The WHAT'S NEW magazine

Popular Science

FEBRUARY 1986 $1.75
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Readers Talk Back

Address letters for this column to: Readers Talk Back, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. Because of the large volume of mail, we are unable to acknowledge unpublished letters.

Space freeze?

In "NASA's Solar Plane" [Oct. '85] you say that the aircraft would store the excess electricity produced by the solar cells. That involves breaking water into gaseous hydrogen and oxygen, then combining the two gases at night to produce water and electricity. But at 65,000 feet, the air temperature is 70 degrees F below zero—won't the water freeze?
Todd Sherry, Farmers Branch, Texas

Jim Schefter replies: "The solar plane is equipped with two things that keep the on-board water liquid: good insulation and a heater that runs on a small amount of the generated power."

Transatlantic flea

No gnat of a boat like the *Virgin Atlantic Challenger* ["Transatlantic Catamaran," Nov. '85] could ever be taken seriously as a successor to the Blue Riband, an honor that was meant to recognize the fastest passenger ship in the transatlantic run. Each one of the winners advanced the art of passenger-ship—not speedboat—technology as they reduced the crossing time.

For all of its 1980s technology and its single-purpose fuel-tank-with-engines construction, when the *Challenger* sank it was a mere 1.5 hours ahead of the pace of the 1952 Riband winner, the *United States*. That great ship displaced 53,000 tons.
David N. Kwechansky, Don Mills, Ont.

What you really save

I think I've found a miscalculation in your otherwise excellent "Fuel-Saving Furnaces" [Oct. '85]. You say that you can save 15 percent on energy bills by switching to an 80-percent-efficient furnace from a 65-percent-efficient furnace. But subtracting one percentage of efficiency from the other isn't the way to figure savings. There's a more accurate way. Let's say the fuel bill for your house is $1,400, and your furnace is 65 percent efficient:

1) $1,400 (fuel bill) × 0.65 (furnace efficiency) = $910 (the amount, without waste, that it really costs to heat your house).

2) $910/0.80 = $1,137 (how much it would cost an 80-percent-efficient furnace to heat your house, or provide $910 of heat).

3) Your savings with an 80-percent efficient furnace would be $263 ($1,400 − $1,137), not $210, as you mention in the article.
Sheila Rice, Assistant Vice President
Marketing and Consumer Relations
Great Falls Gas Co.,
Great Falls, Mont.

I'm designing a superinsulated house for the Lincoln, Neb., area. It requires a furnace to provide 24,000 Btu/h, but I haven't been able to find an efficient gas furnace. Can you suggest one or an alternative heating method?
K. Smits, Slidell, La.

V. Elaine Gilmore replies: "Reader Smits should consult the Gas Appliance Manufacturers Assn. (GAMA) directory, which lists many gas furnaces with a heat output of 20,000 to 35,000 Btu/h. These small furnaces tend not to be the most efficient, but some have ratings of 80 percent and above. You can get a copy of the directory by sending $5 to GAMA Efficiency Certification Program, ETL Testing Laboratories, Inc., Industrial Park, Cortland, N.Y. 13045. With such low heating needs the efficiency of a furnace isn't as important as it is in a house that requires 100,000 Btu/h. Indeed, you might want to consider electric baseboard heaters because of their low initial cost and to eliminate a source of combustion byproducts, which might degrade the air quality in the tight house you are planning."

Radon scare

"Radon Exclusive" [Nov. '85] didn't mention that there are a variety of monitoring services available to homeowners worried about the possible presence of radon. We offer a radon-monitoring system developed and tested by the U.S. Department of Energy's Environmental Measurements Laboratory. Homeowners receive a charcoal canister that can be installed in the basement or the living area of a house. After three months, a homeowner returns the canister; we analyze it and provide a report on the

Continued

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The insulator that

or presenting Transparen

Once upon a time, choosing window glass to let the sunshine in gave you a terrible two-sided problem: Heat Loss in cool, northern climates and Solar Heat Gain in warm, southern climates.

In other words, your windows were always either too cold or too hot.

"These windows are too cold!"

That meant condensation — drops of water — rotting away sills, walls, sometimes even carpeting and draperies.

"These windows are too hot!"

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"Then Ford Glass introduced a window glass that works like transparent insulation."

Then Ford Glass, the second largest glass manufacturer in North America, put their technological expertise to work in the home. We introduced a dynamic, new *solar management* product: Sunglas® Heat Reflective™ glass.

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Sunglas® HR™ glass saves your energy dollars. It actually cuts heat loss, helps manage heat gain, and reduces condensation by keeping the window glass surface warmer. It could even add to the resale value of your home, all without changing its appearance.

"So easy to handle, it's ideal for both new home and replacement windows as well."

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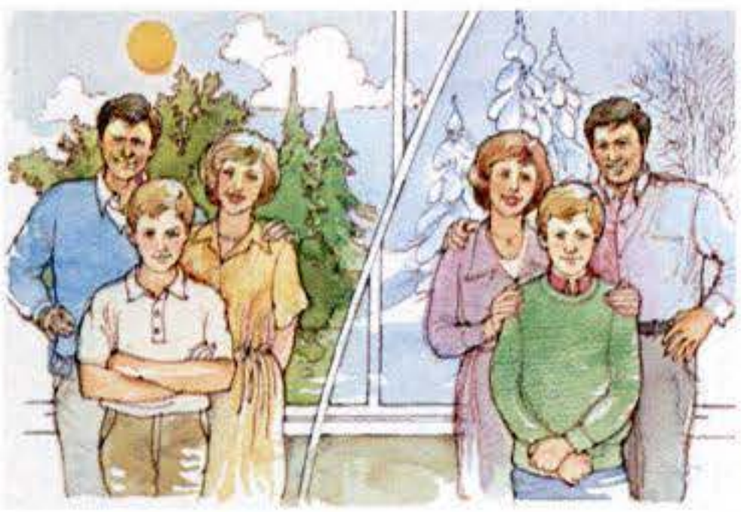
really was a window

nsulation from Ford Glass.

In fact, in typical double-paned home windows, Sunglas® HR™ glass performs like expensive, cumbersome triple glazed windows — without the added weight and risk of breakage or seal failure.



"These windows are just right!"

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*Based upon 1/2" air space. Performance will change with the width of the air space.

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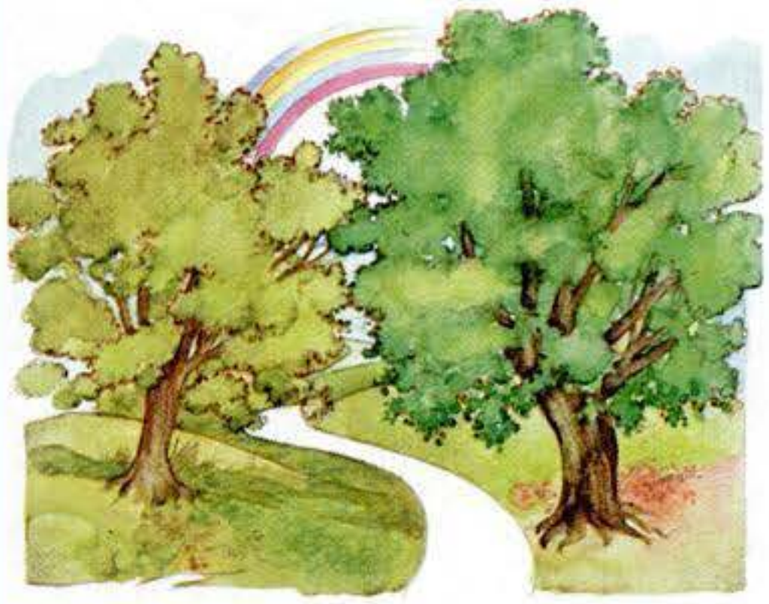

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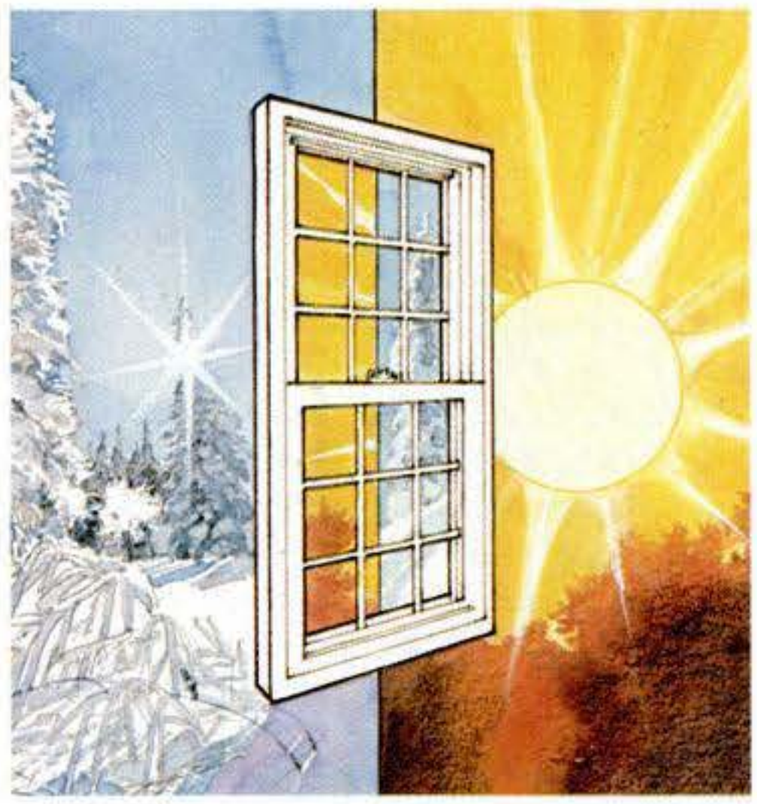

See your local window supplier or for more information and a free brochure call 1-800-GLASS-HR or write to: Ford Glass Division
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Donald F. Shutz, President
Teledyne Isotopes, Westwood, N.J.

Gas-bag blowup

In the September 1985 issue you illustrate an air-bag safety device that ignites sodium azide tablets by stab action on a primer ["Low-Cost, Low-Tech Air Bag"]. It disturbs me that a very toxic substance like sodium azide would be used. When sodium azide comes in contact with an acid, such as sulfuric acid in batteries, it's converted into azoimide, a highly poisonous and volatile liquid.

Patrick J. Kondach
Edmonton, Alta.

Jack Keebler replies: "Reader Kondach is right about sodium azide's unhealthy aspects, and his remarks echo those of automobile-recycling associations. In its application as an experimental air-bag gas generator, however, sodium azide is sealed in a metal canister and is considerably less accessible than the toxic gasoline in the fuel tank or toxic sulphuric acid in the battery."

Hang it right

The "Wallpaper Liner" part of "Install One of These Problem-Wall Cover-Ups" [Sept. '85] omits some necessary steps for hanging the liner. 1) All professional hangers know you should clean the surface with soap before papering. 2) All surfaces, including paneling, should be sealed with a wall preparation before putting up the liner. 3) Hang the liner horizontally —especially when the grooves in the paneling run vertically. By hanging horizontally, there's even less chance of those grooves standing out.

Marshall Deitch, Palm Harbor, Fla.

Rear-drive Scorpio

In "High-Tech Trio from Europe" [Nov. '85], the drawing of Ford's Scorpio doesn't look like that of a front-drive. The illustration shows a longitudinally mounted engine and drive shaft with the differential in the rear.

S. Siclovau, Montreal, Que.

Richard L. Stepler replies: "Reader Siclovau is correct. The Scorpio shown is a rear-drive, with the engine mounted longitudinally. There is, however, a four-wheel-drive version of the Scorpio now available in Europe."

Metal, not wood

Ever notice that all projects in "Wordless Workshop" are made of wood? I can't think of any project that has been made of metal, plastic, or any other material—even when they could have been. I am thinking particularly of October 1985's "Workshop," where Roy Doty made a huge, heavy wooden box to hold flimsy plastic shopping bags. I made a wire frame that hold the bags and weighs far less than a wooden box. Surely folks must send in ideas that could be made of materials other than wood.

Al Sorensen, Salt Lake City, Utah

Al Lees replies: "Doty culls through hundreds of submissions and brings me the best to choose from. He assures me that the overwhelming majority of ideas are for woodworking, and that's reflected in our selection. But we welcome simple projects in other materials —as long as they're not items cut from plastic bleach bottles. March 1985's warming tray, for example, was entirely of metal."

Sunshine-powered fridge

I found "Super-Fridge Can Run on Sunshine" [Nov. '85] a little confusing. Where does the liquid refrigerant in the heat pipe go? It can't go back to the compressor or the evaporator. Also, is there a battery for night and cloudy-day operation?

W. Bud Woods, Evergreen Park, Ill.

Marty Carlock replies: "The heat pipe doesn't connect to the mechanical refrigeration system. When it gets cold enough, the refrigerant vapor in the pipe chill, condenses, and runs down the pipe to the cooling plate in the refrigerator wall. Buried in the cooling plate are fins that, when cooled by the refrigerant, absorb heat from the refrigerated compartment. This heat boils the liquid refrigerant, which rises as a vapor and returns to the heat pipe. The fridge uses a standard car battery that's charged by the photovoltaic panels, so it's the battery that actually runs the refrigerator."

Correction: The prices quoted for plans in "Big Family of Little Houses" [Jan.] are incorrect. The correct prices are $75 for one set and $25 for each additional set ordered at the same time. PS

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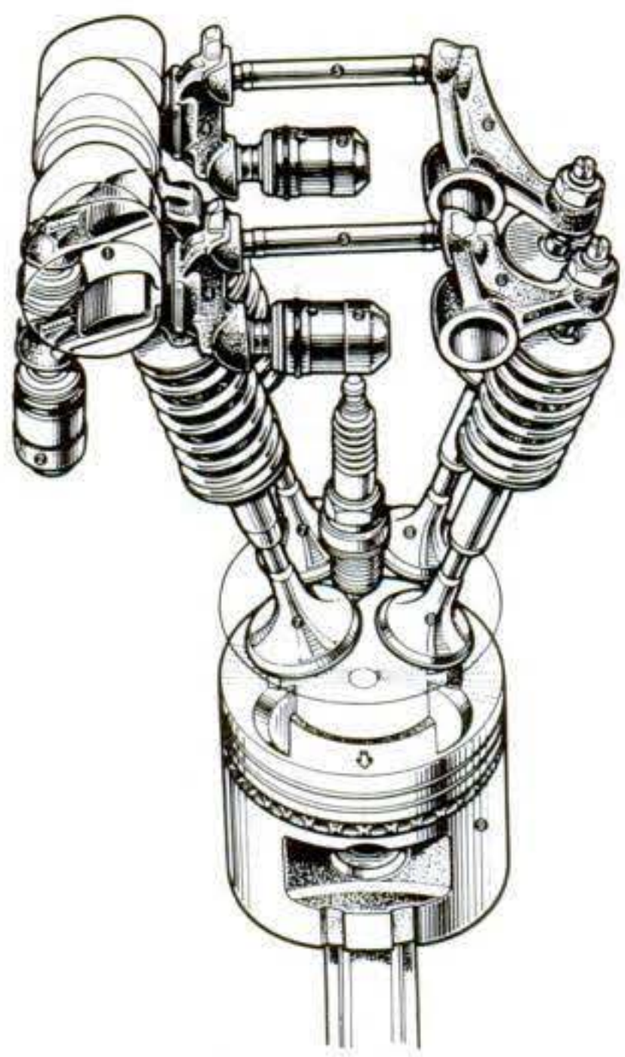
Driving a Legend

Can compact-car-maker Honda compete in the big-car market? This spring the $20,000 Legend begins its courtship with Americans from Honda's Acura showrooms. A test drive in Japan provides mixed impressions.



Honda's unique valve-train layout in the Legend allows a single camshaft to operate four combustion valves.

By KEVIN RADLEY

TOKYO

Honda's engineers looked dismayed when I returned the shiny new Legend with acrid smoke pouring from the wheel wells. But the opportunity to drive Honda's big car on Japan's mountain roads provided some interesting insights into the Legend's braking, handling, cabin comfort, and acceleration limits.

My initial impression of the brakes was one of light pedal action with a powerful grip. But after several fast downhill runs the Legend's four-wheel discs faded to the point that the pedal sank to the floor with little response from the calipers. And soon after the fade, I noticed the smoke.

Brake performance aside, I was generally impressed by Legend. The car handled well for a large vehicle on twisting roads. The longish wheelbase and the heavy engine up front ensured a predictable amount of front-wheel understeer and a generous amount of body roll. Legend is a comfortable car. It's obvious that the double-wishbone suspension up front and in back was tuned for a compliant ride. I found its only real debit to be a tendency to pound over sharp ridges in the road.

Inside the cabin there's a feeling of almost handmade quality. This is tempered by a simple, almost Teutonic, appearance to the controls. Some of these include a digital climate-control system, electric windows, power locks, and power seats. The seats are well contoured without being uncomfortably viselike. And for warmth and comfort, optional pure wool upholstery is available. I would have liked more instrumentation than the basic tach/speedo/fuel/temp pod. But the basic cluster is easy to read and completely reflection free.

One of the most interesting features of the Legend is its engine. The 2.5-liter six mated to an automatic transmission is capable of brisk acceleration. In the right gear, the car gobbles up slopes with gusto despite its 3,070-pound curb weight. The car did, however, downshift frequently to maintain its momentum. Legend's 90-degree V6 produces 151 hp and 157 ft.-lbs. of torque. Honda chose a 90-degree configuration to keep the hood line low for good aerodynamics. And an electronic fuel-injection system feeds the engine's four-valve-per-cylinder combustion chambers. Thanks to a bit of engineering razzle-dazzle, the 12 valves per bank are operated by a single camshaft. Honda engineers chose this arrangement to keep engine width to a minimum. The intake valves, nearest the engine's center line, are operated via short finger rockers, while the exhaust valves are rocker-operated with finger rockers following the cams. It sounds complicated, and it is. But the engine revs easily and fairly quietly to a 6,700-rpm fuel cutoff.

Honda's first big car will be marketed in the U.S. via independent Acura dealerships. By separating the marketing channel, the company hopes to divorce the Legend from Honda's little-car image. In fact, U.S.-bound Acura cars will dispense with all Honda badging, except on the engine's cam covers. Pitched directly against already established European luxury sedans such as Volvo and Saab, the Legend rides on a 108.7-inch wheelbase and stretches to 189.4 inches in overall length. Those dimensions are within inches of most European models. With its 0.32 drag coefficient, four-coat paintwork, and excellent engine power, it's a good bet that the Legend will give some of the large European and American sedans a run for the money. PS

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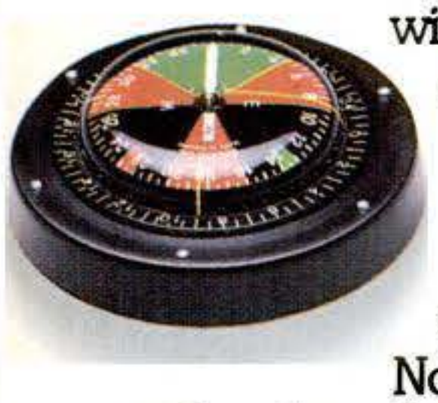

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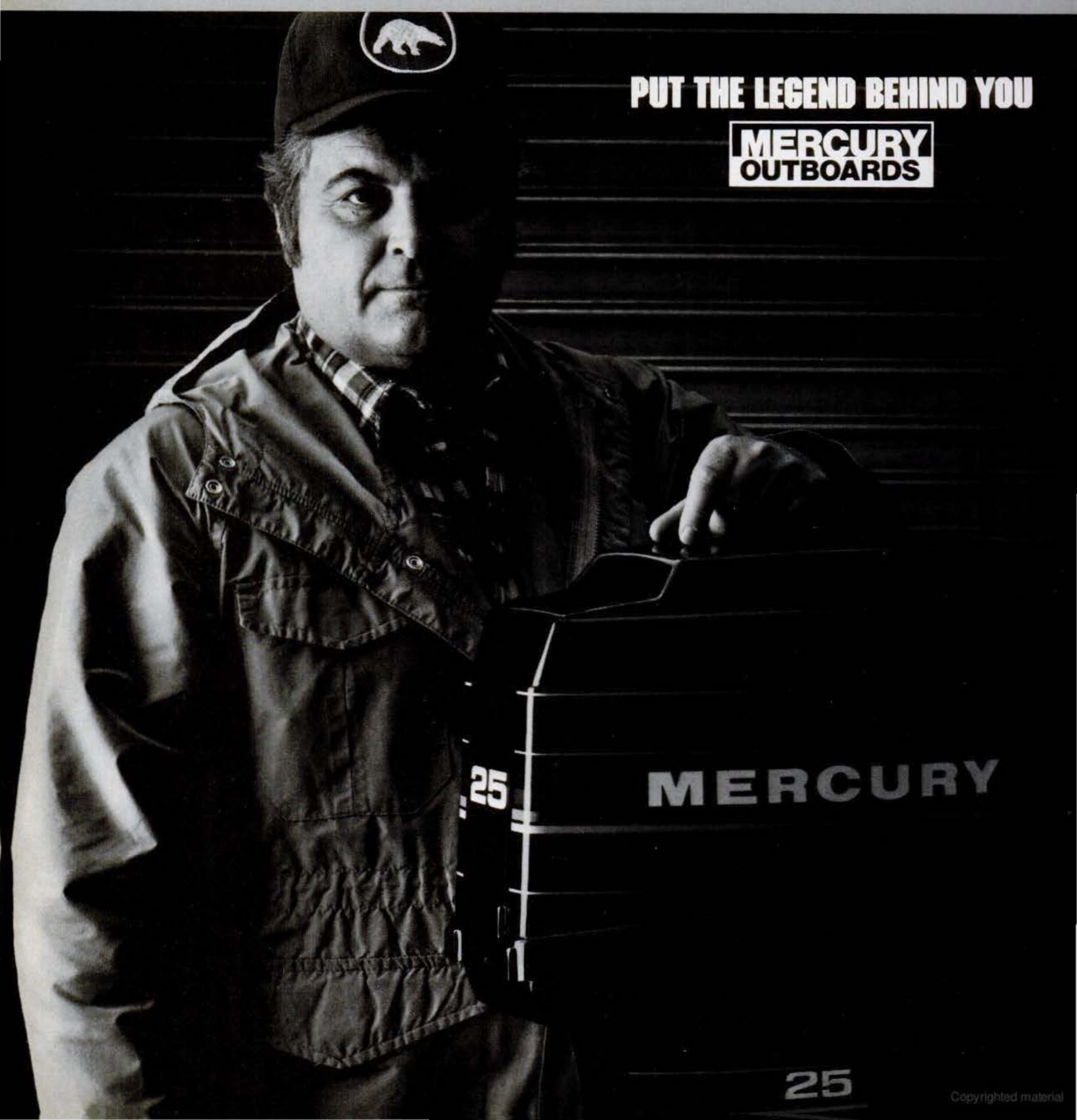

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Science Newsfront

By ARTHUR FISHER

Space galley

Eating in the microgravity of space is no picnic. Extrapolate the problems encountered by shuttle astronauts on short trips to the 90-day jaunts contemplated for crews on the manned space station, and you've definitely got a non-attraction. So engineers at McDonnell Douglas are designing a special space galley—shown in the artist's concept above—that will make the dining experience more palatable. It's part of a $1.5 million contract awarded last April by NASA's Johnson Space Center, in Houston, for the preliminary design of the huge orbiting space station, scheduled for launch around 1993.

The kitchen will have to store a 90-day supply of food for six or seven crew members. It will contain a full complement of amenities—now mostly lacking on the shuttle—including a refrigerator, oven, freezer, dishwasher, trash compactor, food and trash storage, and an inventory-control system. The appliances will be adapted from earthbound kitchen gadgets to operate satisfactorily in a microgravity environment. The idea is to make meals resemble those on Earth as much as possible.

Strange interlude

In our unremitting coverage of peculiar progeny, we bring you, in the picture below, Amo, Britain's first zebra born via embryo transplant, alongside her bemused surrogate mother, Mahogany, a Welsh pony mare.

The unlikely duo was photographed at the London Zoo. The birth was only the second of its kind in the world. It is the outgrowth of continuing research—by biologists and veterinarians at the Zoological Society of London's Institute of Zoology and the Thoroughbred Breeders' Assn. Equine Fertility Unit at Cambridge—into means of preserving rare and threatened species.

Heart disease and cholesterol

The much-debated question of how fatal heart disease and blood cholesterol levels in men are related has apparently been answered by an analysis of a massive study involving 356,222 subjects. In a report to the American Heart Assn. last November, Dr. Jeremiah Stamler, Chairman of the Dept. of Community Health and Preventive Medicine at Northwestern University Medical School, Chicago, said there was "a strong and unequivocal relationship of serum cholesterol to risk for both cigarette smokers and nonsmokers, for both men with normal blood pressure and men with high blood pressure." Moreover, he said, increased risk begins at levels often considered harmless and then "is continuously graded progressively more dangerous the higher you go up the scale of blood cholesterol."

The study was part of the Multiple Risk Factor Intervention Trial, carried out at 25 centers nationwide—the largest of its kind. The men who participated were divided into categories according to age and blood cholesterol level, and were followed for six years. In every age group, the incidence of fatal heart disease increased with the cholesterol level. For example, among the almost 79,000 men aged 40 to 44, the fatal heart-attack rate was only 1.3 deaths per 1,000 men in six years for those in the lowest 20 percent of the serum cholesterol distribution, with levels less than 182 milligrams per deciliter (mg/dL). But for the next higher 20 percent—182 to 202 mg/dL (a level commonly judged safe)—the death rate was 77 percent higher. For the next 20 percent—203 to 221 mg/dL—the death rate was 154 percent (2.54 times) higher; for the fourth 20 percent—222 to 245 mg/dL—269 percent (3.69 times) higher; and for the top 20 percent—above 245 mg/dL—485 percent (5.85 times) higher.

The message is clear, says Stamler: Eat less animal and saturated fat and less cholesterol-containing food, which is the long-held position of the American Heart Assn., the World Health Organization, and many other medical experts.

Earthquake-nuclear risks

How would a nuclear power plant survive a major earthquake—like the one that devastated Mexico City last fall? After five years of subjecting scale models of nuclear plants to the jolting forces of a "great" quake—one registering more than 8.0 on the Richter

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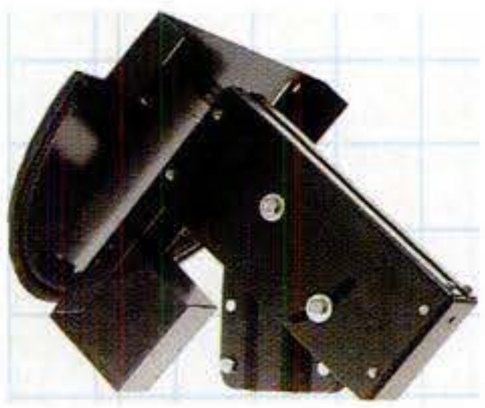

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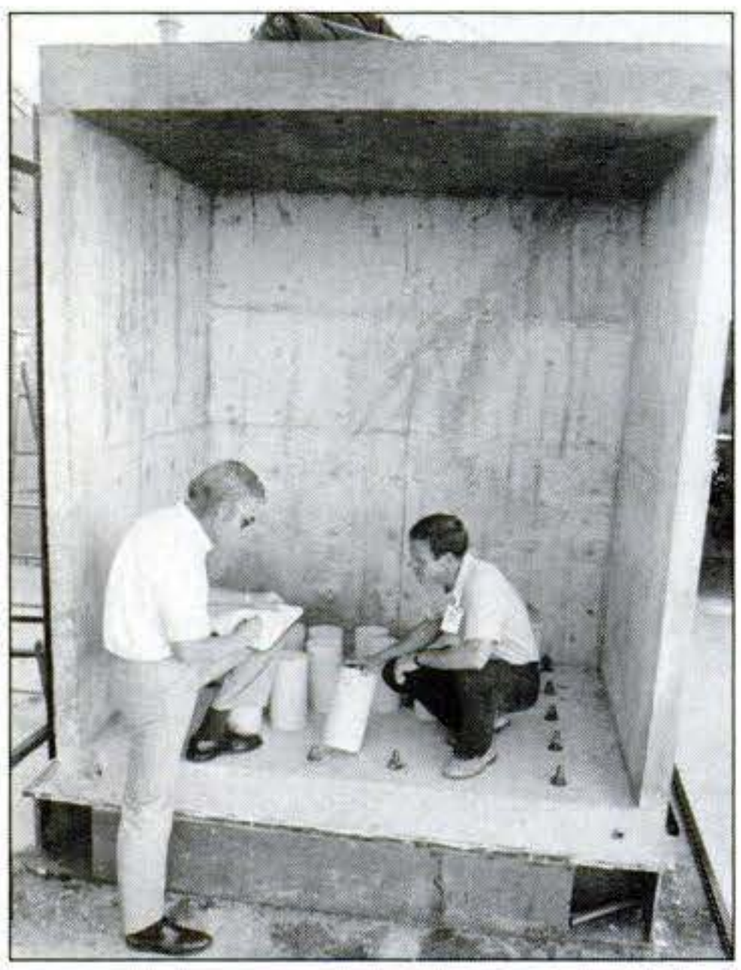
scale—experts at Los Alamos National Laboratory, in New Mexico, conclude that the plants would come through intact.

"It's an important finding. These buildings are very strong. They just will not collapse," say Charles Anderson and Joel Bennett of the Lab's Advanced Engineering Technology Group. Some 31 miniaturized boxlike models, built with steel-reinforced walls and heavily instrumented, were tested as part of an ongoing program conducted for the Nuclear Regulatory Commission.

In the photo below, Anderson (left) and Bennett are preparing the largest scale model of its kind for a new series of tests. Nine feet high and 10 feet across, it has walls four inches thick and will be shaken at the U.S. Army's Construction Engineering Research Laboratory, in Illinois.

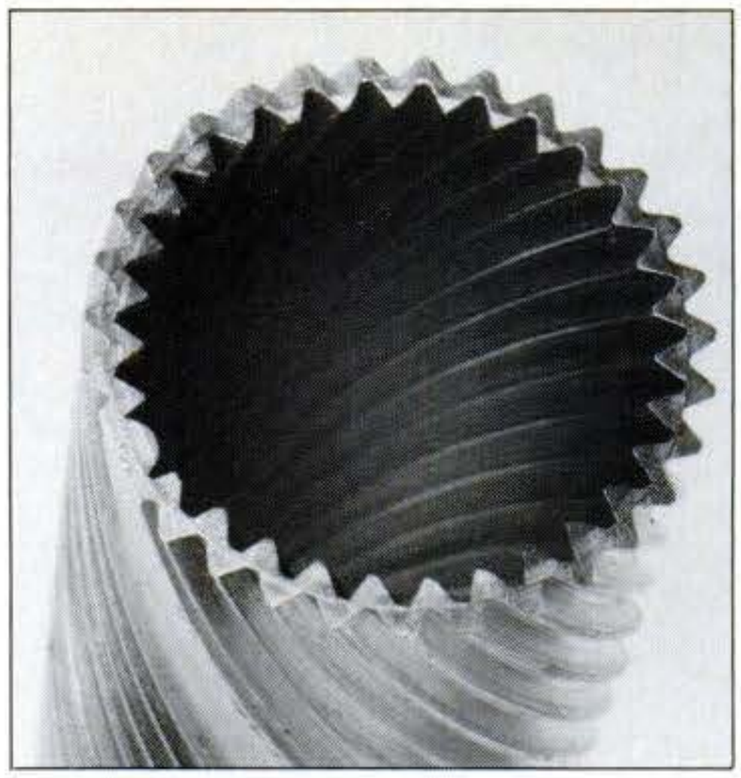


Stardust

Using a helium-cooled detector of their own design aboard NASA's Kuiper Airborne Observatory, University of Texas astronomers have discovered a ring or doughnut of dust around a newly created star in the Sharpless 106 nebula, the first time the shape of such a dust cloud has been seen clearly. The observations were made by Dr. Paul M. Harvey, Dr. Daniel F. Lester, and Marshall Joy, all of the Department of Astronomy of the University of Texas at Austin. Dust clouds around very young stars may be the origin of planetary systems, many astronomers believe.

Fluted heat exchanger

A new heat exchanger with a surprising geometry that promises a two- to



four-times improvement in heat-transfer efficiency over conventional commercial units has been successfully tested at the Dept. of Energy's Argonne National Laboratory, near Chicago. The chief innovation of the new design, according to Anthony Thomas, manager of Argonne's Heat Exchanger Test Facility, is the spirally fluted surface seen in the photo above. In a typical exchanger, a series of tubes carries a fluid through a cylindrical shell containing a second fluid; heat is transferred from one fluid to the other through the walls. In the Argonne design, a series of small triangular tubes about one inch in diameter run in a spiral along the inside and outside surfaces. The fluting increases the surface area of the cylinder and guides the fluid flow (the test used ammonia and hot water). This approach, Thomas says, "increases heat-exchanger performance 1.7 times over that of a heat exchanger that uses simple, smooth tubes." He predicts that the design could significantly increase performance and lower operating costs in chemical processing, oil and gas refining, and power-generating systems that reclaim and use waste heat. It could also be used in geothermal and ocean thermal-energy systems, both of which rely on heat transfer to generate electricity.

Spark plugs out?

Antoni Oppenheim, a senior scientist at Lawrence Berkeley Laboratory's Applied Science Division and a professor of mechanical engineering at the University of California, Berkeley, is pursuing combustion research that may lead to the elimination of spark plugs in future auto engines. Redesigning the operating conditions of the engines, he says, would mean lower pollution, higher fuel efficiency, and an end to the $10 billion socked to consumers each year for the extra cost of producing high-octane gasoline.

"Controlled combustion is the key," says Oppenheim. "The chemistry now being done at the petroleum refinery and later in the catalytic converter . . . could be done in the car engine's cylinder." The rate of combustion in today's cars is so slow, he says, that the octane number of gas distilled from crude oil must be boosted from about 70 to 90—a very expensive process.

Oppenheim's group has found that the most promising alternative to conventional spark plugs is a combination of combustion jet ignitors and recirculation of exhaust gas from the previous combustion cycle.

Back testing

Orthopedists at the University of Texas Health Science Center at Dallas are developing techniques for testing and treating victims of low back pain using isokinetic equipment such as the Cybex Corp. rotation device shown in the photo below. Low back pain afflicts 70 to 90 percent of the U.S. population at some point in their lives, and is the number-one cause of disability in those under 45 (number three in those older). Three different Cybex trunk-testing machines are being used. The machines measure three different aspects of a person's trunk strength: extension and flexion, torso rotation, and lifting ability. Graphic printouts display effort, pain, and fatigue, as well as inappropriate movements. The research is also being extended to the training of dancers and athletes. PS

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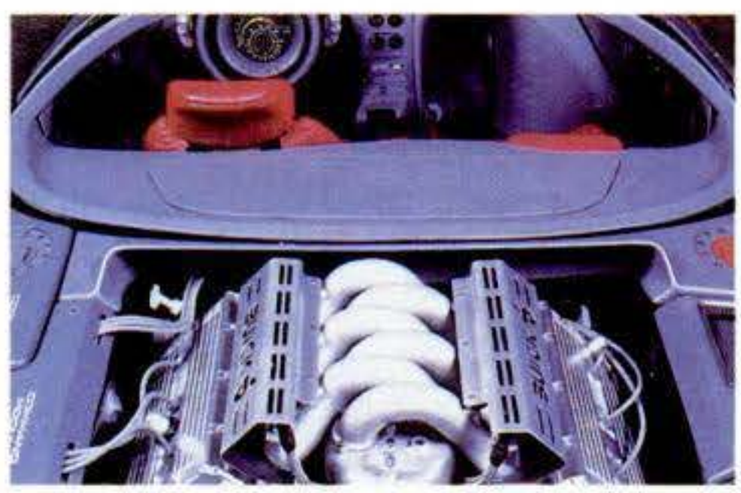
Automotive Newsfront

Wildcat loosed

One of the historic nameplates at Buick Motor Division is back. And it has been stuck on a radically different two-passenger, four-wheel-drive concept car (photo above). The Wildcat's most impressive feature is a 24-valve, 230-horsepower, 3.8-liter V6. The valve train of the engine incorporates direct-acting hydraulic lifters, actuated by four camshafts through a toothed belt-gear array. The power plant (photo) is mounted amidship just ahead of the rear axle. "Clearly, we think this is an engine with an important niche in the future—the near future—of Buick production cars," reports Joseph M. Negri, manager of Buick Special Products Engineering.

The rest of Wildcat is just as interesting. For example, delivering 34 percent of the power to the front wheels and 66 percent to the rear wheels is a special chain-drive transfer case and torque divider. The 34/66 torque split is what Buick considers best for high-performance four-wheel-drive road holding. Other features include an anti-lock braking system, windshield-projected instrumentation, and engine over-rev protection from the clutchless manual shift transmission. The body structure is almost entirely composite carbon fiber and glass. Wildcat doesn't have traditional doors. As the canopy is raised, the steering wheel tilts upward. The driver and passenger then sit on low sills and swing their legs into the interior compartment.



Engine turnaround

Four-wheel drive has already been adopted at some of the European luxury-car companies such as Audi, BMW, Mercedes, and Ford of Europe. So it's not surprising that General Motors' Cadillac division is investigating a four-wheel system. A Cadillac insider recently confirmed that Caddy is now testing an Audi-style full-time layout intended for on-highway use. Reports also indicate that Cadillac appears to be considering a longitudinal, rather than transverse, engine layout. Although the new Eldorado and 1986 Seville sport Cadillac's transverse V8, some important advantages may make a longitudinal engine position more efficient for driving all four wheels. An engine perpendicular to the axle has more room, runs cooler, and may be easier to service. And, as Audi has maintained all along, fore-and-aft engine mounting makes it simple to run a drive shaft to the rear axle.

Trucking, California-style

Nissan's as-yet-unnamed 1986½ mini-pickup (photo) is the first Japanese vehicle to be designed in the U.S. Created by Nissan Motor Co.'s Design International subsidiary in La Jolla, Calif., the vehicle is designed to bridge the gap between the automobile and the truck. "The truck is less of a work vehicle and more of a personal transportation vehicle," says Richard Hoffman, Nissan-U.S.A.'s director of engineering. The angled windshield, sloping hood, and fender blisters are all aimed at giving the new truck a muscular yet aerodynamic look not seen on previous small Japanese pickups. The cab interior is slightly wider and deeper with a bit more head room. The doors are larger. Additional glass gives improved driver vision. Noise and vibration have been reduced to the same levels as in the 300ZX sports car.

Outside, the truck is wider than previous models, which gives it equal cargo space despite its shorter bed. The front and rear wheels are farther apart to provide a stabler ride. And according to Nissan, it's got the greatest ground clearance in its class.

Power plant choices include a fuel-

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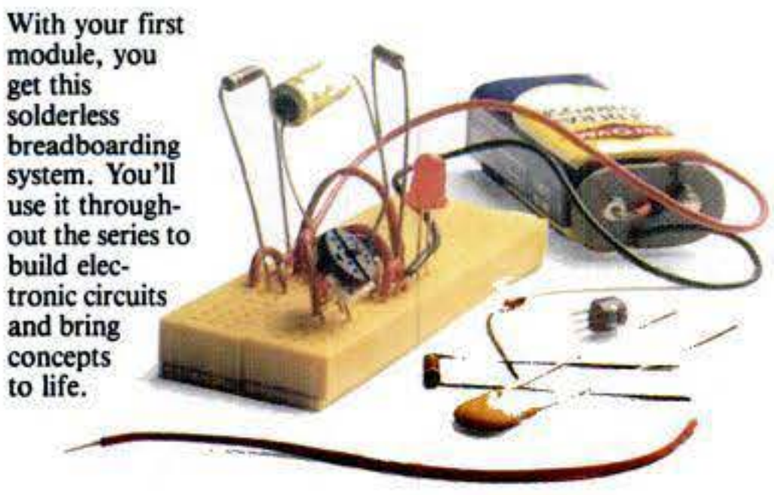

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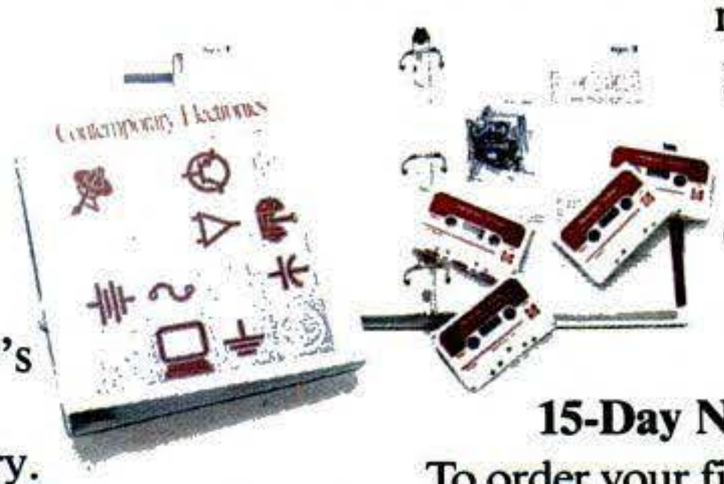

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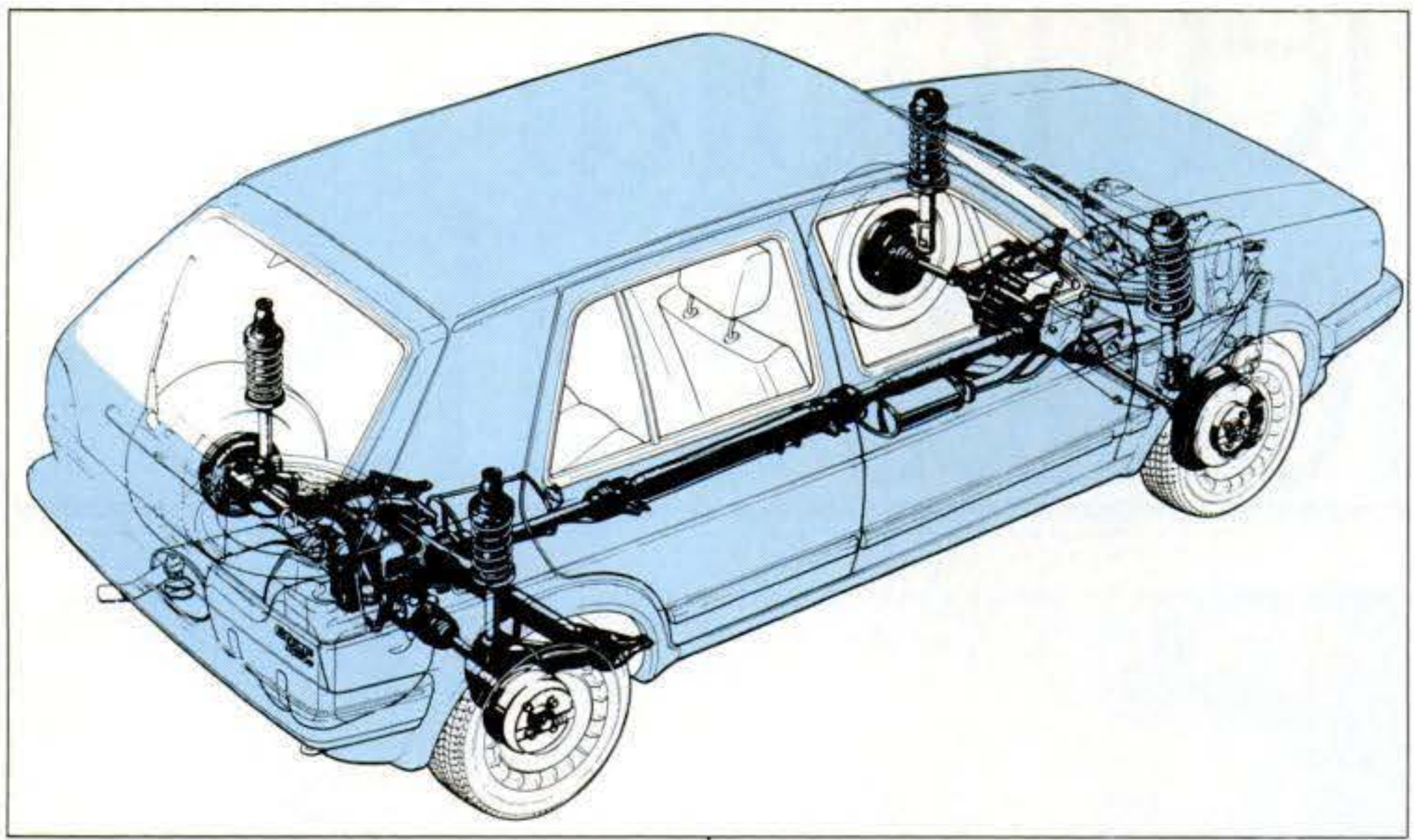

injection three-liter V6 that delivers about 140 hp (the largest in a small truck), and a standard 2.4-liter four-cylinder engine rated at 106 hp. Five-speed manual and four-speed automatic transmissions, as well as a four-wheel-drive system, will be available.

Knock, knock

Saab claims it has come up with a more effective way of sensing preignition that leads to engine knock. Saab does this by reading the spark-plug gap's electrical resistance in each cylinder. Resistance builds at the gap as combustion chamber temperatures increase. Special circuitry developed during work on the Saab Direct Ignition [PS, July '85] senses the fluctuation in resistance. It then sends a signal to the fuel-injection system to enrich the intake charge to cool the combustion chamber, effectively heading off knock before it occurs.

No-springs suspension

Lotus Cars Ltd. is currently working on a suspension system that does away with the springs, shocks, and sway bars of conventional suspensions. The answer, according to Lotus, is a computer-controlled hydraulic strut at each wheel. The system is composed of sensors in the chassis and at each wheel that keep track of bumps, cornering, braking, and acceleration. A superfast response computer then sends signals to the struts to respond appropriately. Lotus claims the system can respond three times as quickly as a conventional steel spring. Cornering roll, brake dive, and changes in weight distribution are compensated for automatically. Lotus admits that the use of the multiple computers and aircraft-type hydraulics made earlier systems cost prohibitive. That also means that even the more compact and less expensive systems currently under development will probably be limited to high-dollar sports coupes and luxury sedans.

Sure-footed Golf

Volkswagen has a new four-wheel-drive version of its European Golf. It's called the Syncro (phantom drawing above). On a straight dry road the front wheels get almost all of the engine's torque. The rear wheels receive power only when extra grip is needed. And engagement and disengagement occur without the driver's awareness. The secret is a viscous coupling between the front and rear axle.

On the Golf the viscous coupling is bolted to the nose of the rear axle's differential. The coupling is a small cylindrical casing nearly filled with silicon oil. The driven input shaft carries a stack of perforated steel discs. These interface with slotted discs on the coupling's output shaft to the rear axle. When there is no difference in speed between the two stacks, there is little coupling. But if the front axle's speed is higher (slippage), the speed differential between the plates causes a wiping, or shearing, of the silicon oil. The shear creates friction, which heats up the fluid. The higher the fluid temperature, the greater the viscosity (thickness) of the oil.

The Golf Syncro's rear-drive layout called for an entirely new rear suspension. The torsion-beam rear axle is replaced by an upswept tubular subframe that clears the differential assembly and supports the coil-sprung semi-trailing arms. Up front, the standard transverse differential is modified to take an angled drive for the rear axle's drive shaft. The extra hardware adds about 200 pounds to the Golf's normal weight.

Rolling showcase

Subaru's F-9X experimental car (photo below left) is a showcase for that company's latest body aerodynamics, engine, and drive-line hardware. Subaru says that the shape was inspired by aircraft work conducted by the car maker's parent company, Fuji Heavy Industries. The sloped nose and raked windshield provide low wind resistance for quiet high-speed cruising and fuel efficiency. For additional stability, the F-9X features a large rear spoiler with small winglets. Like many new airplanes, much of the F-9X's body is constructed of composite materials for high strength and low weight.

Providing power for *both* the front and rear wheels is a flat four-cylinder engine. Good engine breathing is afforded by four valves per cylinder. Further enhancing engine intake efficiency is an intercooler, supercharger, and turbocharger. When the engine speed is low (up to 5,000 rpm), the supercharger provides trigger-quick response. Above 5,000, the turbocharger takes over the engine-boost duty. Subaru boasts that the two-liter engine develops close to 355 hp at 8,000 rpm. Top speed, according to the company, is 186 mph. PS

Contributors: Dan McCosh (Detroit), Jack Keebler (New York), Jim Schefter (West Coast), David Scott (Europe).

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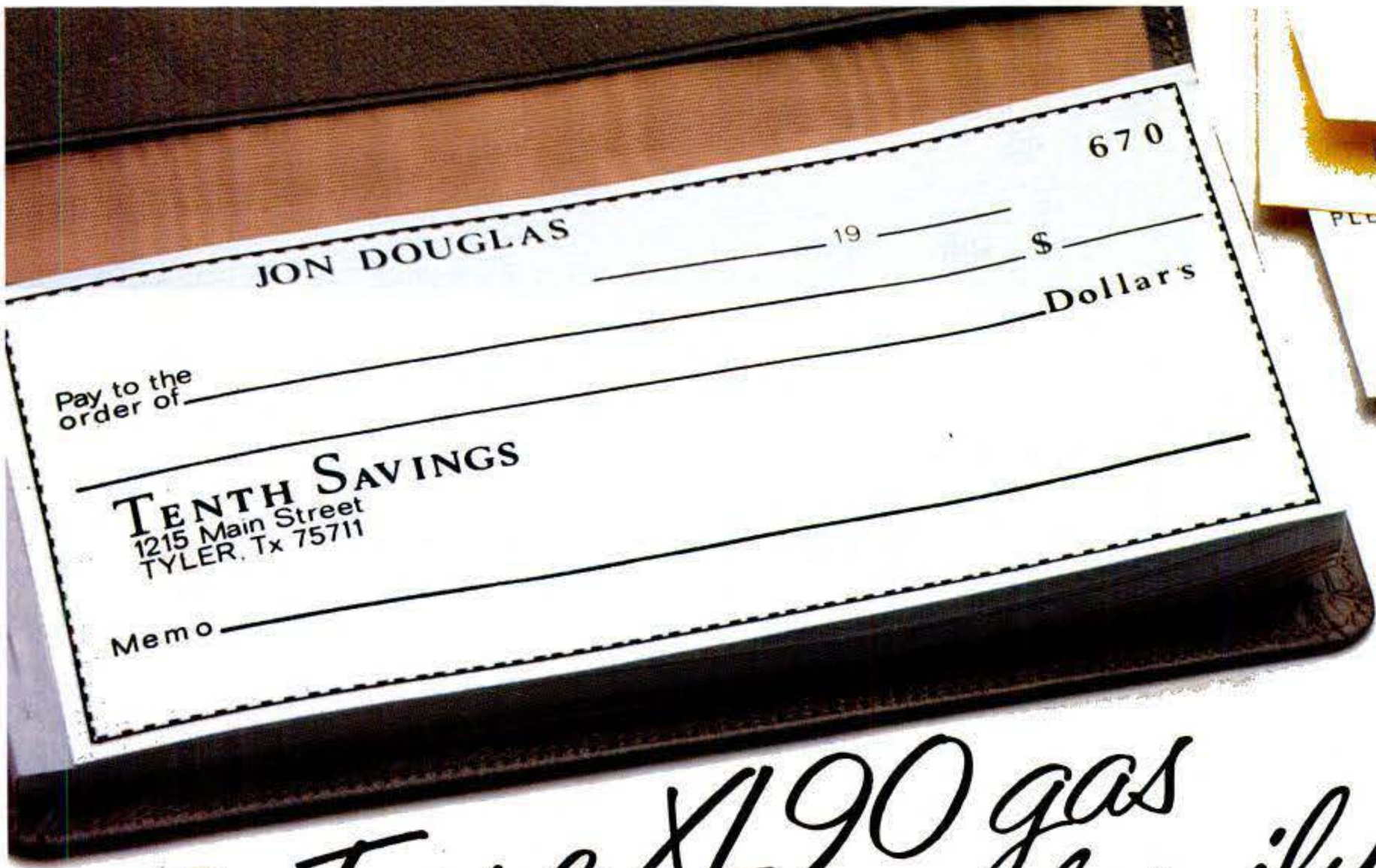

The Trane XL 90 gas furnace. Your family budget's best friend.

Trane's new high efficiency gas furnace can significantly reduce your home's fuel use.

We don't have to tell you how hard it is to keep to a budget these days. But we *can* offer help. With the Trane XL 90—a superb fuel economizer that can keep your home heating costs down.

The efficiency you need.

The XL 90 comes in five sizes to match every home's heating need. They have efficiency ratings from 90% to 95%. Which means that almost all of the gas an XL 90 burns is translated directly into usable heat.

Energy savings means cash savings.

If your present furnace is ten or more years old, chances are its efficiency is only around 60% to 65%. Replacing it with a new Trane XL 90 can make a big difference in your fuel consumption. And, even if your furnace is less than ten years old, it may pay you to replace it with a fuel-saving XL 90 now instead of later.

Annual heating cost with a 65% efficient conventional gas furnace (Example ranges)	$800	$1000	$1200
What you can save per year with 93% efficient XL 90	$240	$300	$360

These figures are for comparison purposes **only. Your actual savings will depend on** where you live, your home's construction and **local utility rates. Read the important** energy cost and efficiency information available **from your dealer before purchasing.**

Efficient gas heat—your best buy.

When it comes to warming a house quickly, quietly and dependably, gas heat can't be beat. No wonder most homeowners throughout the country prefer the warmth and comfort of gas heat. And the new Trane XL 90 delivers that comfort for less.

What's more, the energy-saving performance of the XL 90 is backed by a 20-year limited warranty.

Talk to an expert.

Your Trane dealer's professional analysis of your home's heating needs will determine exactly which XL 90 model will give you the most comfort with the greatest savings.

To find the Trane dealer nearest you, look in your local Yellow Pages. You'll make a friend you can count on.

TRANE™

50 Million people take comfort in it™

When you compare the cost and comfort of all energies, gas now gives you even more for your money.

Gas. America's best energy value.

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The forecast calls for

Thunderbird.

On the road, an impending storm presents a special challenge—one the driver of a Thunderbird is well-prepared to accept.

Thunderbird's electronically fuel-injected engine provides the power. Steel-belted radial tires and rack and pinion steering provide the grip. And for further stability and road control, Thunderbird's shape helps reduce front and rear lift.

Inside, you'll find the appointments of a true driver's car. Thunderbird's airflow management reduces wind noise and helps keep the windows clean. Seating areas provide lateral support for cornering. And to minimize the time your eyes are off the road, the instrument cluster provides vital information at a glance.

Of course, Thunderbird does have its limits; it can't predict the weather. It can, however, make dealing with a storm a little easier. You can drive a Thunderbird at your nearby Ford Dealer. Have a nice day.

3-Year Unlimited Mileage Warranty.

The new 3-year unlimited mileage warranty covers major powertrain components on 1986 Ford cars. Warranty is limited and certain deductibles apply. Ask to see the 3-year unlimited mileage warranty when you see your Ford Dealer.

Best-built American cars.

"Quality is Job 1." A 1985 survey established that Ford makes the best-built American cars. This is based on an average of problems reported by owners in a six-month period on 1981-1984 models designed and built in the U.S.

Have you driven a Ford... lately?

Buckle up—Together we can save lives.

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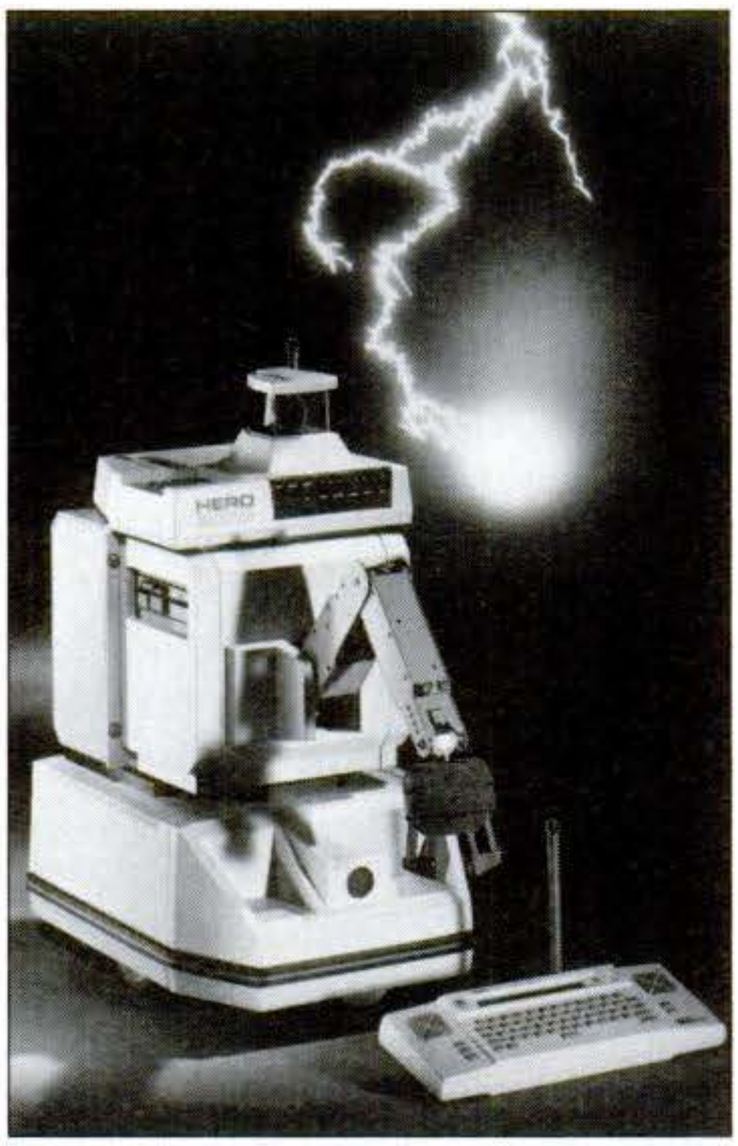
Electronics Newsfront

By WILLIAM J. HAWKINS



The three-foot-high plastic-and-metal body had been scurrying around the room for hours, then suddenly stopped. "I'm getting tired," it said. The voice was clear but mechanized, not human. "I must find my battery charger." Its single arm retracted and its upper torso began to twist.

"Hero 2000 has determined that its battery is low," James Lytle, product line manager for Heath, told me at the company's headquarters in St. Joseph, Mich. "It's now looking for its recharger by scanning the room with a beam of infrared light."

Hero 2000 is Heath's newest robot, a replacement for the original Hero 1 [PS, May '83]. Like Hero 1, the 2000 is designed for education, but its advantages over its predecessor are additional speed, dexterity, strength, and intelligence. "When the recharger is struck by the light," said Lytle, pointing to a small box in the corner of the room, "it will send out another infrared light beam to confirm its location to Hero."

"I found it," interrupted Hero, as its wheel-driven base turned and began to move in the correct direction.

The robot's single arm contains an elbow and wrist for moving its gripper into nearly any position. The gripper's "fingers" are linked to a motor drive through a clever spring-torquing system. "By measuring the amount of twist on the spring when the grippers close," said Lytle, "the internal microprocessors can compute the amount of applied force. That gives Hero 2000 a sense of touch."

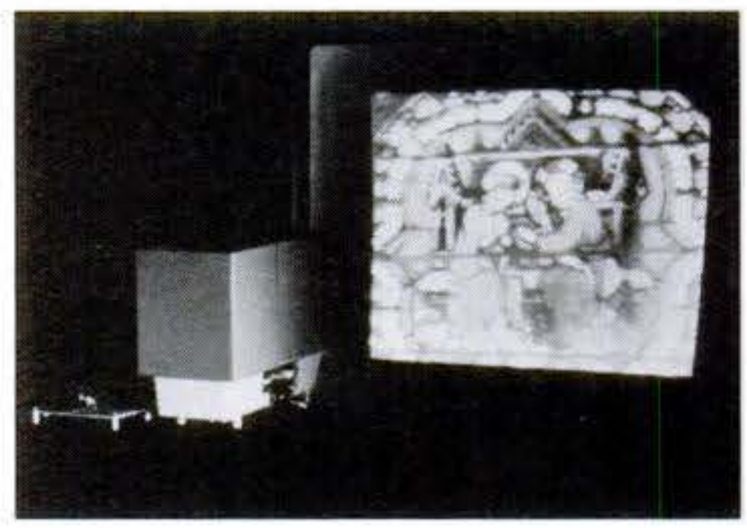
Its two independent drive motors are microprocessor controlled, too. "To keep Hero on course, each wheel is checked for position. If one turns more or less than the other," said Lytle as he gave the robot a gentle shove in the wrong direction, "Hero knows it has hit something and compensates."

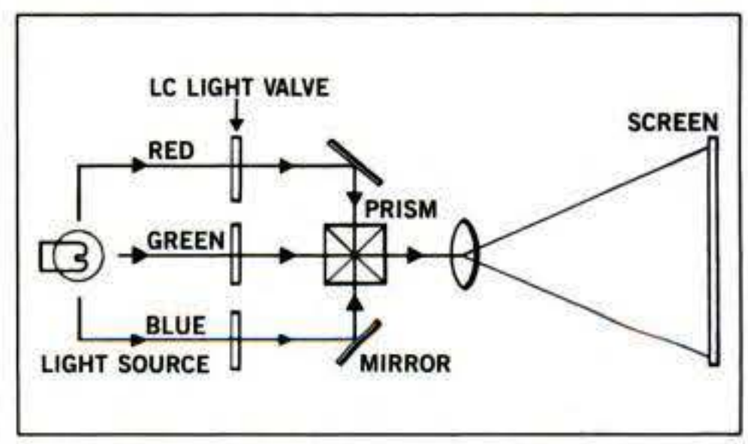
"Get out of my way. Robot coming," said Hero, and it corrected its course to the recharger. While the program that homes the robot to its charger is available from Heath, Hero 2000 accepts other instructions directly from a wireless keyboard (via R.F.) up to 100 feet away or from a personal computer connected to the keyboard.

It took about five minutes for the robot to dock with its charger. "I get a real charge out of this," said Hero. In kit form, Hero 2000 is $3,000; $4,500 for a wired version.

LCD projection TV

"Third-generation LCDs are just starting to appear," said Toshiaki Saito, director of research and development for Suwa Seiko-Epson, at a recent New York seminar. "These are suited for high-resolution color television displays." That's not news if you own one of the new pocket TVs [PS, Nov. '85], but Saito had bigger things in mind: He demonstrated a new LCD front-projection system capable of displaying a 100-inch diagonal picture. The





three 1.27-inch LCDs, backlighted by a single Halogen or Xenon lamp (see drawing), replace the cumbersome projection tubes now in use. Result: the projector is just 6 by 8½ by 14 inches, and it weighs only 11 pounds.

Complete control

Making all my audio-video gear work together is a problem I solved with Akai's three new components: an SS-V20 controller ($650), a PS-V20 processor ($350), and a DI-V5 distribution amplifier ($160).

Like other controllers, the SS-V20 (bottom in photo) accepts up to six stereo audio-video inputs (tuner, disc, auxiliary, and three VCRs) and allows you to watch one source while taping another. But unlike the others it contains a 4.5-inch color video screen and stereo speakers for monitoring a recording or readying material for dubbing.

The PS-V20 video processor's front controls let you change the audio and

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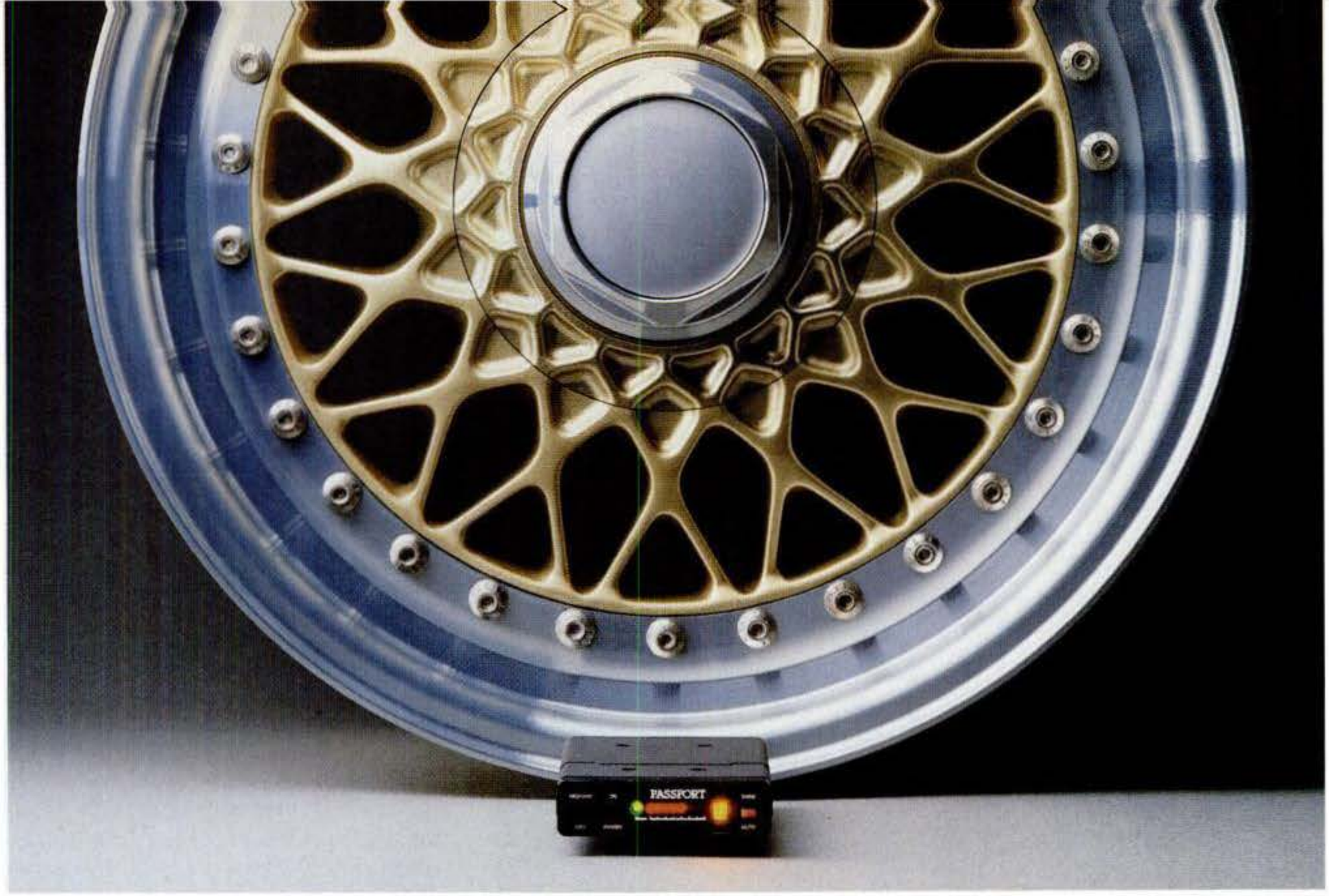

Small Wonder

It's here, *pocket-size* radar protection.

Imagine a superbly crafted electronic instrument, powerful enough to protect against traffic radar, miniaturized enough to slide into a shirt pocket, beautiful enough to win an international design award.

Small means nearly-invisible protection

That could only be PASSPORT. It has exactly what the discerning driver needs, superheterodyne performance in a package the size of a cassette tape.

This miniaturization is possible only with SMDs (Surface Mounted Devices), micro-electronics common in satellites but unprecedented in radar detectors. It's no surprise that such a superlative design should be greeted by superlatives from the experts.

"In a word, the Passport is a winner," said *Car and Driver.*

The experts report excellent performance. Simply switch PASSPORT on and adjust the volume knob. Upon radar contact, the alert lamp glows and the variable-pulse audio

Small means the size of a cassette tape

begins a slow warning: "beep" for X band radar, "brap" for K band. Simultaneously a bar graph of Hewlett-Packard LEDs shows radar proximity.

As you get closer, the pulse quickens and the bar graph lengthens. Should you want to defeat the audible warning during a long radar encounter, a special switch provides silence, yet leaves PASSPORT fully armed for the next encounter. A photocell adjusts alert lamp brightness to the light level in your car. PASSPORT was designed for your protection *and* your convenience.

In PASSPORT, 102 SMDs (right) do the work of ordinary transistors, resistors and capacitors.

PASSPORT comes with a leather case and travels like a pro, in your briefcase or in your pocket—to the job for trips in the company car, on airplanes for use in far-away rentals. Just install on dashtop or visor, then plug into the lighter. PASSPORT keeps such a low profile. It can be on duty without anyone noticing.

Small means an easy fit in the briefcase

One more PASSPORT convenience—call us direct. It's toll free. We make PASSPORT in our own factory and we'll be happy to answer any questions you may have. If you decide to buy, we'll ship your PASSPORT within 24 hours by UPS, and we'll pay the shipping. For an extra $6.00, Federal Express guarantees 48-hour delivery.

If you're not satisfied within 30 days, return PASSPORT. We'll refund your purchase and your return shipping costs. There are no hidden charges.

Isn't it time for a PASSPORT of your own?

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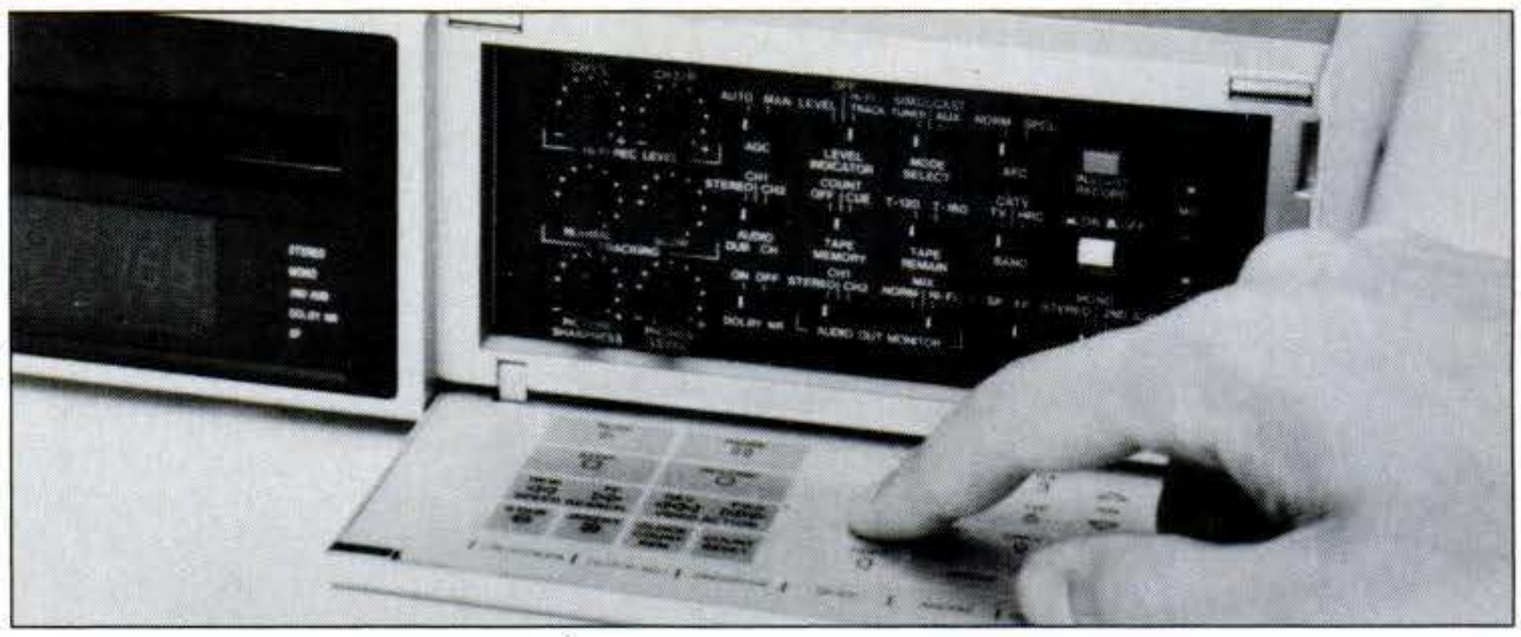
video signals in a variety of ways. For instance, an "Enhance" control boosts video signals up to nine decibels for a crisper image. And a front-mounted joy stick lets you correct overall color or change the color in specific areas of a scene for special effects. Audio signals are enhanced by a built-in DNR noise-reduction system (lowers hiss by 10 decibels) and a stereo synthesizer. For editing, there are audio-video fader controls.

The DI-V5 distribution amplifier (top in photo) is used for large installations. It amplifies a single audio-video source for use with up to five components such as multiple VCRs.



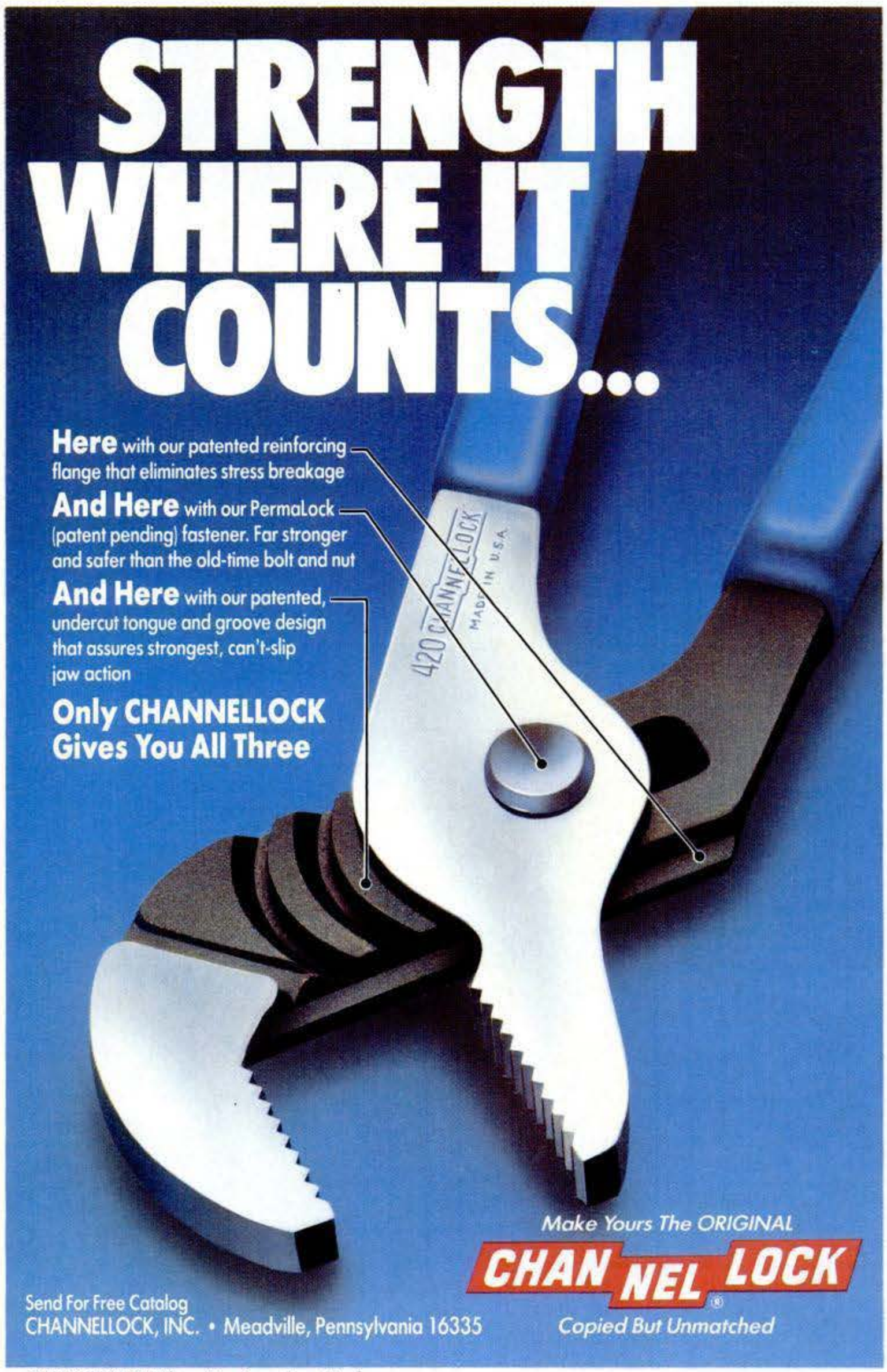
HQ is coming

HQ (high quality) is a new video-processing system developed by JVC for VHS video recorders. It has been nicknamed "Super VHS" (in response to Sony's Super Beta), and the Zenith VR4100 ($1,099) above is one of the first machines to use it. The system uses two comb filters to eliminate video noise and color streaking, and it extends the high-frequency range by 20 percent in the SP and EP speeds for sharper images. HQ tapes are compatible with the standard VHS format.

Goodbye, floppy disks?

EEPROMs (electrically erasable, programmable read-only memory) are memory chips that retain information even when power is removed. When used in a computer, they could eliminate the need for a data-saving peripheral such as a disk drive. That hasn't happened yet because present EEPROMs can hold only about one kilobyte (K) of data. But a few companies, like Advanced Micro Devices, Intel, and Seeq Technology, have shown a new EEPROM-manufacturing technique that squeezes more on the chip by working in areas as small as a few atoms. The chips can be produced economically and contain from 64K to 256K of data. Goodbye, disks? Not yet....

Maxell will soon demonstrate a new computer disk that uses perpendicular recording—magnetic particles are perpendicular to the substrate, as opposed to horizontal as they are on conventional disks. The advantage: much greater density. One 5.25-inch floppy can hold a whopping eight megabytes of data. Presently, there are no perpendicular disk drives announced by manufacturers. Could Maxell know something we don't? PS



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Get down to fundamentals... Experience the joys of woodworking

Are you missing out on the joys of woodworking? Imagine for a moment the shine in your little girl's eyes the first time she sees the rocking horse you built just for her. Or think of the fun you'd have on a deck added to your house — built with your own hands. Maybe the cooks in your family would like a kitchen custom-made to their needs. Or consider how much enjoyment you'd get from your stereo system if you built your own entertainment center.

Unlike many other hobbies, woodworking is a hobby of the imagination as well as the hands. Starting with nothing more than an idea, you create things that express your individuality, creativity and common sense. You solve problems, learn new skills — and save money in the process. But most of all, woodworking is fun.

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...with special tools and professional-quality know-how.

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We back all our products with an iron-clad guarantee and warranty. There's a toll-free number you can call with your woodworking questions and problems. We're committed to your woodworking education through owner's manuals, classes, seminars, magazines and catalogs. All this is part of the Shopsmith Difference, the reason Shopsmith is for better woodworkers and those who want to be.

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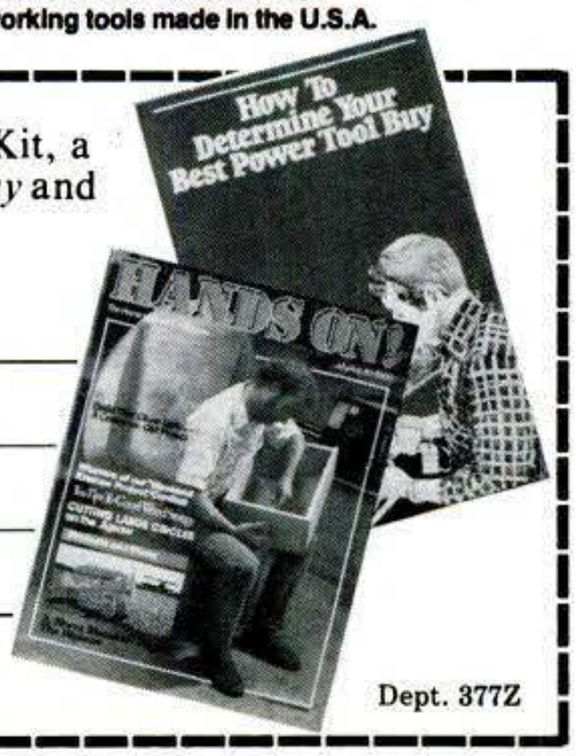

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POPULAR SCIENCE CAR TEST #203
Total cars tested to date: 732

Pickup showdown

—*can Detroit hold off the imports?*

The Ford Ranger XLT displays good form during a 28-mph run through the cones in the low-speed maneuverability test.

The compact-pickup field is one of the most hotly contested arenas in the auto marketplace. That competition has bred a group of small import and domestic trucks with powerful V6 engines, good handling, and luxurious interiors. POPULAR SCIENCE put three U.S.-built haulers through instrumented tests to find America's best bite-size pickup.

By JACK KEEBLER
Photos by Greg Sharko

The best-selling car in America last year was a pickup truck. In 1985, compact pickups, including the imports, grabbed a 28-percent share of the total truck market. Why are trucks so popular?

To find out, POPULAR SCIENCE took American Motors' new Comanche, Chevrolet's S-10 Tahoe, and Ford's Ranger XLT to Stewart International Airport, in Newburgh, N.Y. There we conducted instrumented acceleration, high-speed handling, low-speed maneuverability, and braking tests.

I found that there are several reasons for the pickup truck's growing popularity. First, most owners admit that they coast around much of the time hauling a load of fresh air. But pickup drivers are quick to point out that few vehicles are handier to have around when the occasional awkward load shows up. And with more leisure time available, Americans have discovered ski mobiles, dirt bikes, and ATVs—not to mention home projects requiring lumber, pipe, and fencing.

Second, smart pickup builders realized that early pickups, whether empty or lightly loaded, were painfully hard riding. The result is a new generation of smooth-stepping independent front suspensions. A big increase in engine performance is another reason for the attraction. Today, lightweight powerful V6 engines give compacts quick acceleration and larger trailer and load-hauling capacity. And, finally, the small-truck breed has undergone a hefty amount of cabin refinement. Interior appointments and convenience equipment now rival those in the best sedans.

There remains, however, one area badly in need of improvement, which appears to be the Achilles heel of an otherwise superb group of trucks: instability during panic stops. More about that later.

Wheelspin

One of the areas of biggest improvement for small pickups has been engine power. That's why I was surprised at the lackluster performance of the Comanche's General Motors-supplied 2.8-liter V6. It was more than five seconds slower to 60 mph (18.5 seconds) than the Chevrolet S-10 (13.4). The Chevy had essentially the same engine, with minor differences in carburetion. (A fuel-injection-equipped 1986 S-10 was not available in time for our test.) Much of the difference was directly attributable to the power-gobbling three-speed automatic transmission in the Comanche.

The acceleration champ, however, was the Ranger. With its optional fuel-injection 2.9-liter V6, it easily bested its competitors at 11 seconds. Acceleration runs were marked with lots of tire smoke and wheelspin. Unfortunately, like performance sedans with large engines, the Ranger's heavy clutch-return spring quickly tires your left leg in city traffic.

Two of the trucks in this test were four-wheel drives: the Chevy S-10 and the Ford Ranger. Shifting the Chevy

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"For me, learning about electronics is the first step to where I want to go in life."

SP4 Rich Parsons, HAWK Missiles

"When I was a little kid, I dreamed about being an astronaut. Or working with space-age technology. Now the Army's preparing me for a future, in high technology. All I have to do is go for it.

"I work on the HAWK high-power radar. Talk about complicated. It's like a puzzle made of circuit boards. It takes a really experienced technician to figure it out, fit the puzzle together and make it work. Since I'm the supervisor, I need to know it. Inside and out.

"Right now, I feel I'm standing tall on the mountain. With my electronics experience—real, hands-on experience—my future can go in a lot of different directions. All of them point up."

The Army could be your connection to a high-tech future.

For more information, contact your local Army Recruiter or call toll free 1-800-USA-ARMY.

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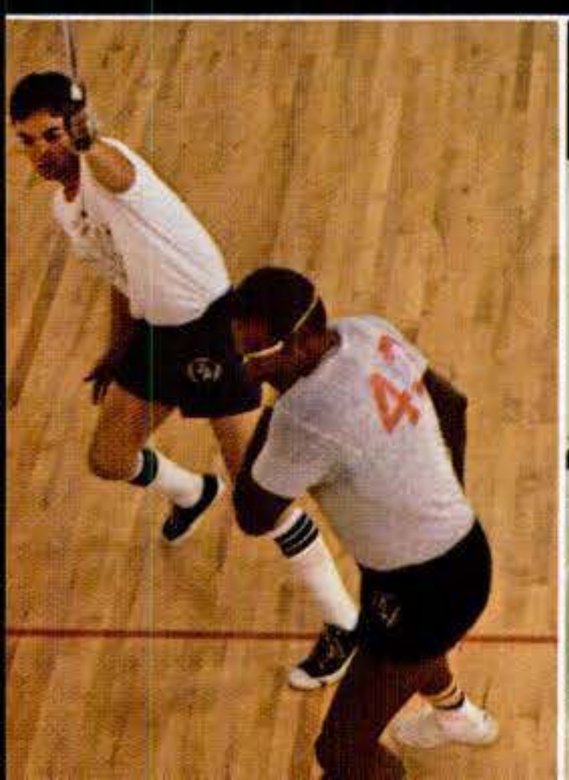
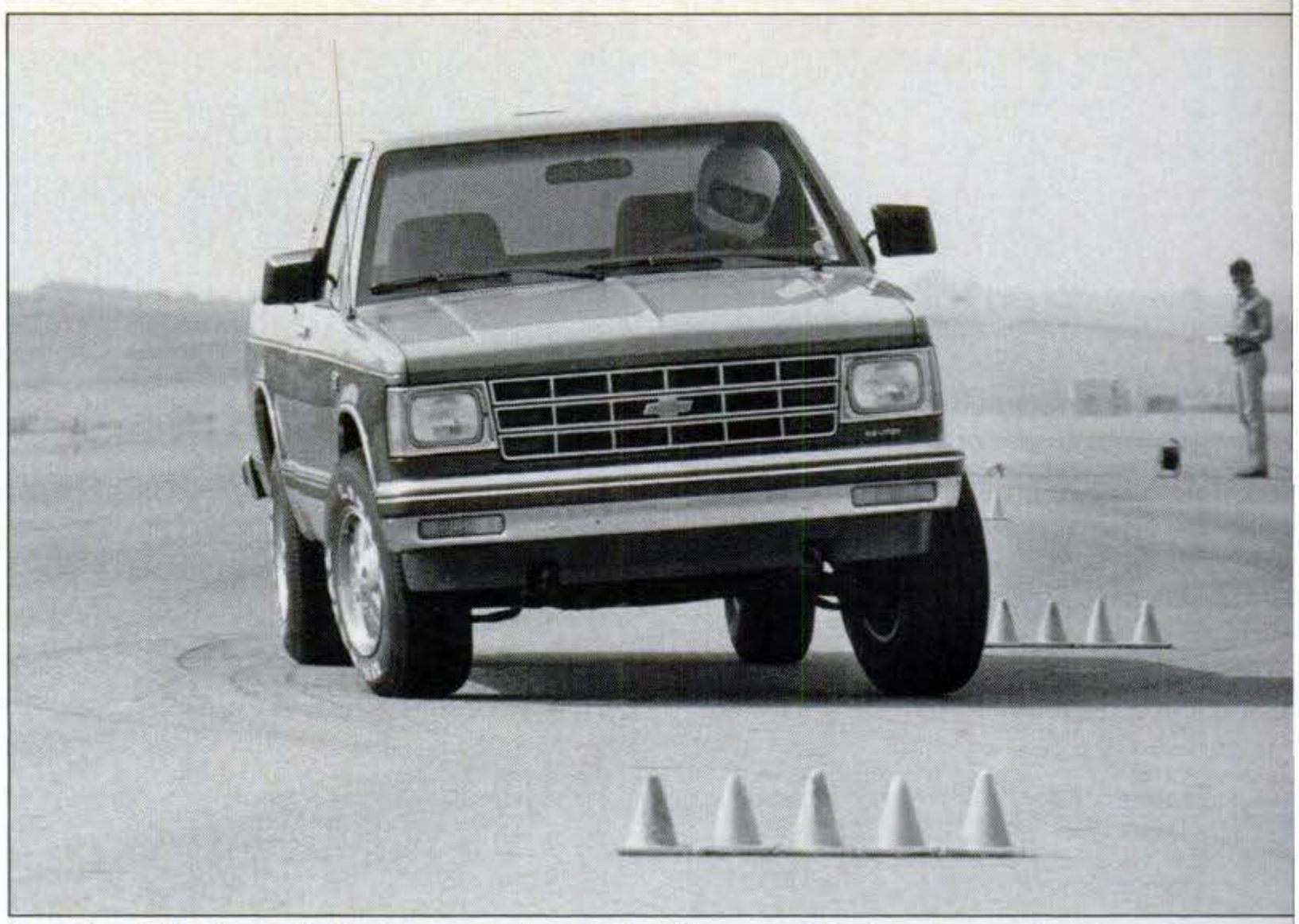


PS ratings— test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	AMC Comanche	Chevrolet S-10 Tahoe	Ford Ranger XLT
Acceleration	2	5	5
Braking	2	1	2
Handling	4	4	5
Maneuverability	5	5	5
Quietness	0	2	1
Roominess	3	3	3
Vision	3	3	3
Entry/exit ease	3	2	2
EPA economy	2	2	3
Ride comfort*	2	3	2

*Author's opinion



Jogging left through the low-speed test, the Chevy S-10 wins an excellent grade.

AMC Comanche displays its civilized manners in the high-speed brake lane.

in and out of the four-wheel range is fairly straightforward. A lever on the floor next to the shifter switches the transfer case smoothly and quickly. I have only one small complaint: It's a long reach from the driver's bucket seat.

The Ranger has a better arrangement, which Ford calls Touch Drive. Touch a small switch on a console above the rear-view mirror, and the truck pops into or out of four-wheel operation. Another switch on the same console activates the transmission's low range for heavy tractor-like power.

High-speed handling

I thought the S-10 and Ranger would be at a distinct disadvantage in this arena. I was wrong. Their high centers of gravity and mud and snow tires did not prove handicaps. The Chevy tied with the AMC for second place, while the Ford again stole the crown. In this event the Ranger managed a 2.5-mph margin over its competitors. It's probably safe to assume that all the trucks were greatly aided by their narrow tracks and taut suspensions.

Low-speed footwork

It's not exactly the "Texas Two-Step," but the low-speed grid requires a similar type of sure precision from the steering and suspension. And apparently none of these pickups had two left feet. Owners appreciate this type of low-speed handling when they need to dodge a stump in an open field, a shopping cart in a crowded parking lot, or a broken bottle on a local street. Again the 4 × 4s seemed to suffer no disadvantage. The Comanche and Ranger tied at 28.6 mph. The Chevrolet was just ½ second behind at 28.1.

Comfort

Without question, the Ford and Chevrolet provided a more comfortable ride than the AMC. I feel that this was due in large measure to the independent front suspension of the Ranger and S-10. AMC chose to fit its new pickup with a beam axle in front. Although not as noticeable on smooth highways, even slight road irregularities fairly shout about the Comanche's primitive axle.

The interiors of these test vehicles are plush. Some of the options now available include inflatable lumbar seats, tilting wheels, graphic equalizer AM-FM radios, power door locks, aluminum-alloy wheels, power steering, and electric windows. Both the Chevrolet and Ford added to their luxury impression by fielding extended-cab models. Behind the tall, soft bucket seats in each pickup is a narrow storage area. In the Chevy, two folding jump seats with seat belts are bolted to the area's outer bulkheads. They're just large enough for adults for a short trip or for children. The Ford's extended-cab option featured two large covered compartments in the same po-

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It's Unanimous

(Even the competition says ESCORT's the one to beat)

It's easy to see who sets the pace in radar warning. Just read all the detector ads. Most of them claim to be as good as ESCORT. A few say they're better.

At least they agree on one thing. ESCORT is the one they have to measure up to.

A modern classic

ESCORT was a radical piece of electronic engineering in 1978 when it was introduced, the first practical use of superheterodyne technology to warn of police radar. *Car and Driver* magazine said, **"...the radar detector concept has finally lived up to its promise."**

Since then, our engineers have never stopped refining that technology. ESCORT may look the same on the outside, but it never stops getting better on the inside.

Standard of comparison

Now, when experts refer to the high-water mark in radar protection, they automatically turn to ESCORT. In March of this year, *Car and Driver* published its latest detector test, this one comparing remote-mounted models. ESCORT is designed for dashtop or visor mounting. But the magazine included ESCORT in the test anyway, as the reference against which the performance of the others would be measured. ESCORT scored 412 points in the final rating, compared to 274 for the highest-finishing remote. You might say the comparison showed that there is no comparison.

A gilt-edged reputation

Seven years is a long time in the radar warning business, but there is no shortcut to a good reputation. *Car and Driver* said, **"The ESCORT radar detector is clearly the leader in the field in value, customer service, and performance..."**

These excerpts were taken entirely from advertisements for other radar detectors.

So it's easy to understand why other detectors would try to stand in our limelight. ESCORT has seven years worth of credibility, the one quality that money can't buy in this business.

Check our references

Credibility doesn't come from extravagant claims. It comes from satisfying customers. You probably know someone who owns an ESCORT (nearly a million have been sold). So ask about us.

ESCORT pioneered superheterodyne receiving circuitry. Ask if our radar warnings always come in time.

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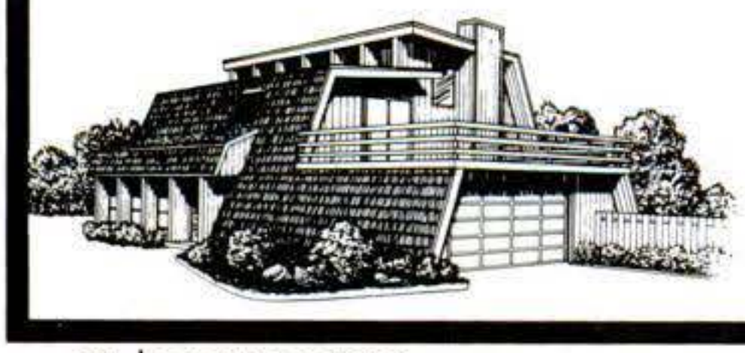

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Pickup showdown

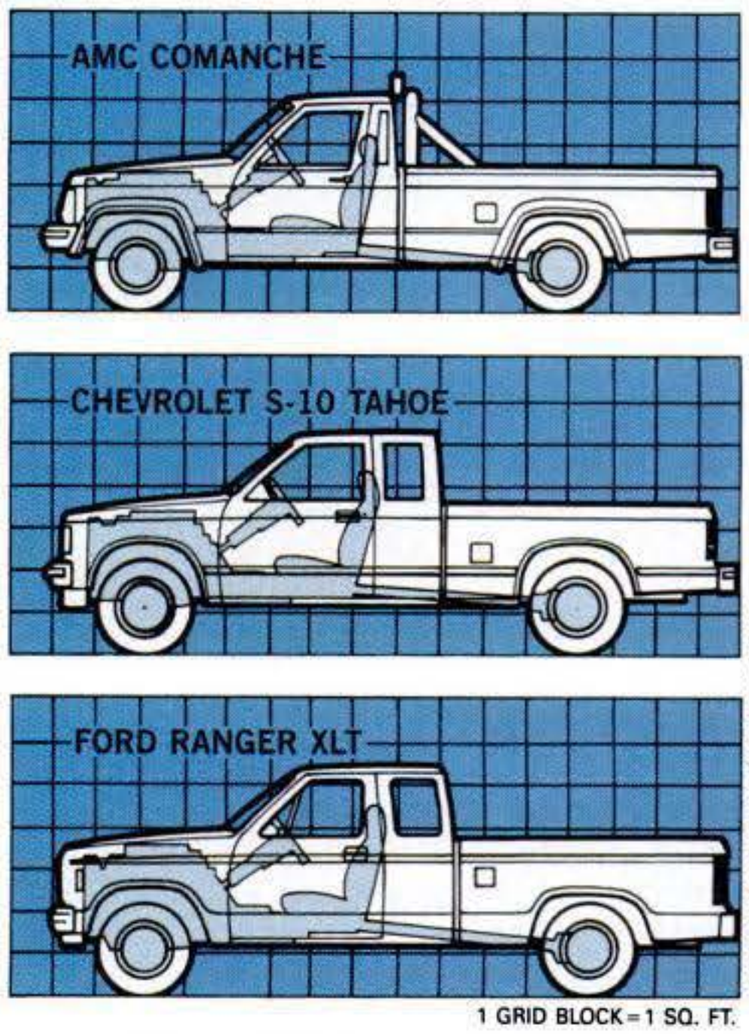
Continued

sitions as the Chevy's jump seats. In addition, the Ford had a shade, similar to that in some hatchback sedans, that could be pulled across the rear area to provide security from the criminally curious.

The Achilles heel

A 60-to-zero-mph panic stop in these unloaded pickups is a wild ride. In fact, it's more than a little like a stint on a

Continued



DRAWINGS BY RUSSELL VON SAUERS

PS serviceability ratings

How easy is it to service these cars? To give you an approximation of how difficult it is for a typical person to perform various service operations, we examine each test vehicle. The numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty; 4, easy; 5, very easy.

	AMC Comanche	Chevrolet S-10 Tahoe	Ford Ranger XLT
Checking fluid levels			
Battery	5	5	5
Master cylinder	3	5	5
Windshield washer	5	5	5
Engine oil	5	3	5
Coolant	5	5	5
Checking the engine			
Spark plugs	4	3	3
Distributor	3	3	3
Carb adjustment	—	—	F.I.
Oil filter	4	2	3
Oil fill	5	3	3
Replacing hoses			
Upper radiator hose	5	5	5
Lower radiator hose	4	3	3
Heater hoses	5	2	4
Changing bulbs			
Headlights	4	2	4
Taillights	3	3	4
Front running lights	3	2	4
Front parking lights	3	2	3
Front directionals	3	4	4
Rear directionals	3	3	4
Rear running lights	3	3	4
Checking fuses	3	2	2
Spare-tire accessibility	3	3	3
Changing belts	3	3	3

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Atari Explodes

Atari's new computer serious threat to Macintosh. Will the Amiga survive?

The Atari 520 ST is a serious challenge to the Apple Macintosh and will open up a major fight in the personal computer market.

By Joseph Sugarman

Imagine this. If I could offer you a Macintosh computer—(a computer that sells for over $2000)—for one third the price, you might wonder.

But what if I offered you a better computer with none of the disadvantages of the Mac and what if I added new features which improved its speed and performance? That's exactly what Atari has done in an effort to grab the ball from Apple and really explode into the personal computer market.

HEADING EFFORT

Heading the effort at Atari is Jack Tramiel—the same man who built Commodore into a billion dollar corporation, sold more computers than any other man in the world and believes in giving the consumer incredible value without sacrificing quality. The new Atari is a perfect example.

First, let's compare the new Atari ST to the Macintosh and the Commodore Amiga. Sorry IBM, we can't compare the ST to your PC because yours is almost five years old, much slower, and, in my judgement, over priced.

Price The cheapest you can get the Macintosh with 512K of memory is $1800 with a one-button mouse, a disk drive and a monochrome monitor. The Amiga sells for $1995 with a two-button mouse, a disk drive and a color monitor. The Atari ST sells for $699 with a two-button mouse, a disk drive and a monochrome monitor and for $200 more, a color monitor. Read on.

Monitor With the Mac you can only use its 9" monochrome monitor and with the Amiga you can only use its 12" color monitor. With the ST you have a choice of either a 12" monochrome or high-resolution color monitor or your own TV set.

Resolution The number of pixels or tiny dots on a screen determine the sharpness of a computer monitor. The Mac has 175,104 pixels and has one of the sharpest screens in the industry. The Atari ST has 256,000 pixels or almost a third more than the Mac. And the Atari color monitor compared to the Amiga in its non interlace mode is 128,000 pixels or exactly the same.

Power All the computers have a 512K memory with a 68000 CPU operating with a 32-bit internal architecture. But Atari uses four advanced custom chips which cause the CPU to run faster and more efficiently giving it some tremendous advantages. For example, it has a faster clock speed of 8Mhz compared to the Mac's 7.83 and the Amiga's 7.16. And the speed of the unit is hardly affected by the memory requirements of the monitor which in the Amiga can eat up much as 70% of the unit's cycle time or speed.

Keyboard This is the part I love. The Mac has a small 59-key keyboard and a mouse. That's all. The 95-key Atari has both a mouse, cursor keys, a numeric keypad and ten function keys. The keyboard looks fantastic and is easy to type on. Although the 89-key Amiga has almost all the features of the Atari keyboard, it looks like a toy in comparison. (Sorry Commodore, but that's my opinion.)

Disk Drive The Mac's 3½" disk drives run at variable speeds—slowing down as they run. The Atari 3½" drives run faster at a constant speed—and quieter than any other unit.

Features The Atari ST comes equipped with the same printer and modem ports as the IBM PC—a parallel and RS232C serial port. The Mac comes only with a tiny non-standard serial and modem port. The ST has a hard disk interface capable of receiving 10 million bits per second. There are two joy stick ports and a 128K cartridge port for smaller programs or games. It has 512 colors (for the color monitor), it has a unique MIDI interface into which you can plug your music synthesizer and record or play back your music.

Software Right now, the Mac has more than the Atari ST and the Amiga combined. The Atari is a new system but the track record of Atari's Jack Tramiel and the potential of the new unit is causing a flood of new software titles. In fact, I'll predict that eventually the Atari will have more software than the Mac. There are now hundreds of titles, from word processing to spread sheet programs, from graphics and games to data base management—all with those easy drop-down menus and windows. There's plenty from which to select now and plenty more to come.

If you think I'm enthusiastic over the ST, listen to what the press is saying. *Byte Magazine* just called it the "Computer of the year for 1986." *Creative Computing* exclaimed, "Without question, the most advanced, most powerful micro computer your money can buy." and finally, the Atari ST is the best selling computer in Europe and acclaimed, "The computer of the year," by the European personal computer press.

I am going to make the ST so easy to test in your home or office that it would be a shame if you did not take advantage of my offer. First, I will offer the computer itself for only $299. You will need, in addition, either one or two disk drives and either an Atari monochrome or color monitor or your own TV. If you order with your credit card during our introduction I will ship your order and only bill you for the postage and 1/3 the purchase price. I will also add a few software packages free including "Logo"—a beginners programming language, a disk for programming in BASIC and Neochrome—a graphics paint program.

COMPARE THE TWO

After you receive the Atari ST, put it next to your Mac or Amiga or even IBM. See how extremely sharp the graphics appear, discover what a perfect word processor it is, how great the keyboard feels and finally how much faster and quieter it runs.

If you're not convinced that the Atari is far superior to your present computer and a fantastic value, simply return it and I'll refund your modest down payment plus our postage and handling charges. If you decide to keep it, I'll bill your credit card account for the remaining balance and enroll you in our discount software club (a $50 value) that lets you buy software for up to 50% off the retail price.

But act fast. We have only 2,000 units and 1,000 free memberships that we will offer as part of this introductory program and we are certain they will go fast. Order today.

To order, credit card holders call toll free and ask for product by number (shown in parentheses). Please add $20 per order for postage and handling. (If you pay by check, you must pay the full amount but we will provide you with a bonus software package.)

ST Keyboard, CPU & Mouse(4060N) **$299**
Disk Drive (4056N) **199**
Monochrome Monitor (4057N) **199**
RGB Color Monitor (4058N) **399**

Note: A list of software will come with the unit.

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mechanical bull in adrenalin-pumping unpredictability. Only pumping the brakes to prevent rear-wheel locking —and careful steering—kept any of the trucks inside the lane.

To be fair, the Comanche was easier to control than the Ranger or S-10. But even with Comanche's brake-proportioning valve—sensitive to bed loading—AMC failed to fully prevent rear brake lockup. Note that none of the pickup trucks garnered better than a poor grade in this important test. The Chevy S-10 took the most serious black eye with a 207-foot hot stop marked by sideways drifting.

Author's choice

I have to go with the Ranger. Its superior power, top handling, and easy-to-operate four-wheel-drive system make it my choice.

Test results, dimensions, and specs

	AMC Comanche	Chevrolet S-10 Tahoe	Ford Ranger XLT
TEST RESULTS			
Acceleration (sec.)			
0–60 mph	18.5	13.4	11.0
Brake test (cool) 60–0 mph			
Stopping distance (ft.)	173	171	188
Pedal pressure (lbs.)	60	42	45
Brake test (hot) 60–0 mph			
Stopping distance (ft.)	185	207	184
Pedal pressure (lbs.)	35	55	35
Interior noise @ 60 mph (dBA)	75	68	69
Handling test (mph)	64.7	64.7	67.1
Maneuverability test (mph)	28.6	28.1	28.6
EPA FUEL MILEAGE (mpg)			
Highway	19	23	22
City	17	16	18
Calif. city	17	16	18
TEST CONDITIONS Ambient temperature, 45° F; relative humidity, 85%; barometric pressure, 30.2 in. Hg			
DIMENSIONS (inches)			
Wheelbase	119.9	122.9	125.0
Overall length	195.5	192.8	192.7
Overall height	63.7	63.4	68.2
Overall width	71.7	64.7	66.9
Track, F/R	57.0/57.0	55.6/55.1	56.5/55.1
Ground clearance	7.5	6.9	6.8
Front head room	39.2	39.1	39.2
Front hip room	55.3	50.7	54.8
Front leg room	39.9	42.5	42.4
SPECIFICATIONS			
Engine type	V6	V6	V6
Displacement (cu. in./L)	173/2.8	173/2.8	179/2.9
Compression ratio	8.5:1	8.5:1	9.3:1
Carburetion	2 bbl.	2 bbl.	F.I.
Net hp @ rpm	115 @ 4,800	115 @ 4,800	140 @ 4,600
Net torque (ft.-lbs.) @ rpm	150 @ 2,100	150 @ 2,100	170 @ 2,600
Transmission	3-speed automatic	5-speed manual	5-speed manual
Axle ratio	4.10:1	3.73:1	3.73:1
Tire make	Michelin	Uniroyal	Uniroyal
Tire type	Radial X	Laredo	Laredo
Tire size	P215/75R15	P235/75R15	P205/75R15
Steering	Power, recirculating ball	Power, recirculating ball	Power, recirculating ball
Overall steering ratio	15.2:1	16.5:1	17.0:1
Turns, lock to lock	3.5	3.2	4.0
Turn diameter (ft.)	41.3	43.8	43.5
Front suspension	Coil spring, live axle with leading links and track bar	Independent, torsion bars	Twin-Traction Beam, coil springs
Rear suspension	Hotchkiss, leaf springs	Salisbury axle, leaf springs	Leaf, two-stage variable rate
Front stabilizer-bar diameter (in.)	0.95	1.1	1.125
Rear stabilizer-bar diameter (in.)	—	—	0.75
Payload (max. lbs.)	1,200	1,500	1,625
Brakes	Disc-drum	Disc-drum	Disc-drum
Brake swept area (sq. in.)	—	—	345.32
Fuel tank (gal.)	16.0	20.0	14.5
Liftover height (in.)	27.81	44.10	23.09
Curb weight (lbs.)	3,423	3,107	3,065
F/R weight distribution (%)	53/47	—	61/39
Base price	$7,049	$8,756	$8,571
Price as tested	$12,348[1]	$14,815[2]	$10,533[3]

Major options (over $100) [1]XLS package $905, automatic transmission $670, V6 engine $437, interior decor group $343, P215/75 R15 tires $332, aluminum wheels $325, power steering $274, sport bar $255, stereo AM-FM radio $177, chrome rear bumper $176, sport decor group $143, protection group $124, console with arm rest $112, sliding rear window $111; [2]Tahoe equipment $1,011, air conditioning $705, off-road chassis equipment package $643, ETR-AM STR-FM stereo with seek scan $594, operating convenience package $325, power steering $260, locking-differential rear axle $238, cast-aluminum wheels $238, V6 engine $225, chrome rear-step bumper $217, electronic speed control $195, 5-speed manual transmission $175, two-tone paint $167, tinted glass $135, tilt wheel $115; [3]rapid spec package $1,085, off-road tires $219, deluxe two-tone paint $200, aluminum wheels $188, cloth captain's chairs $181

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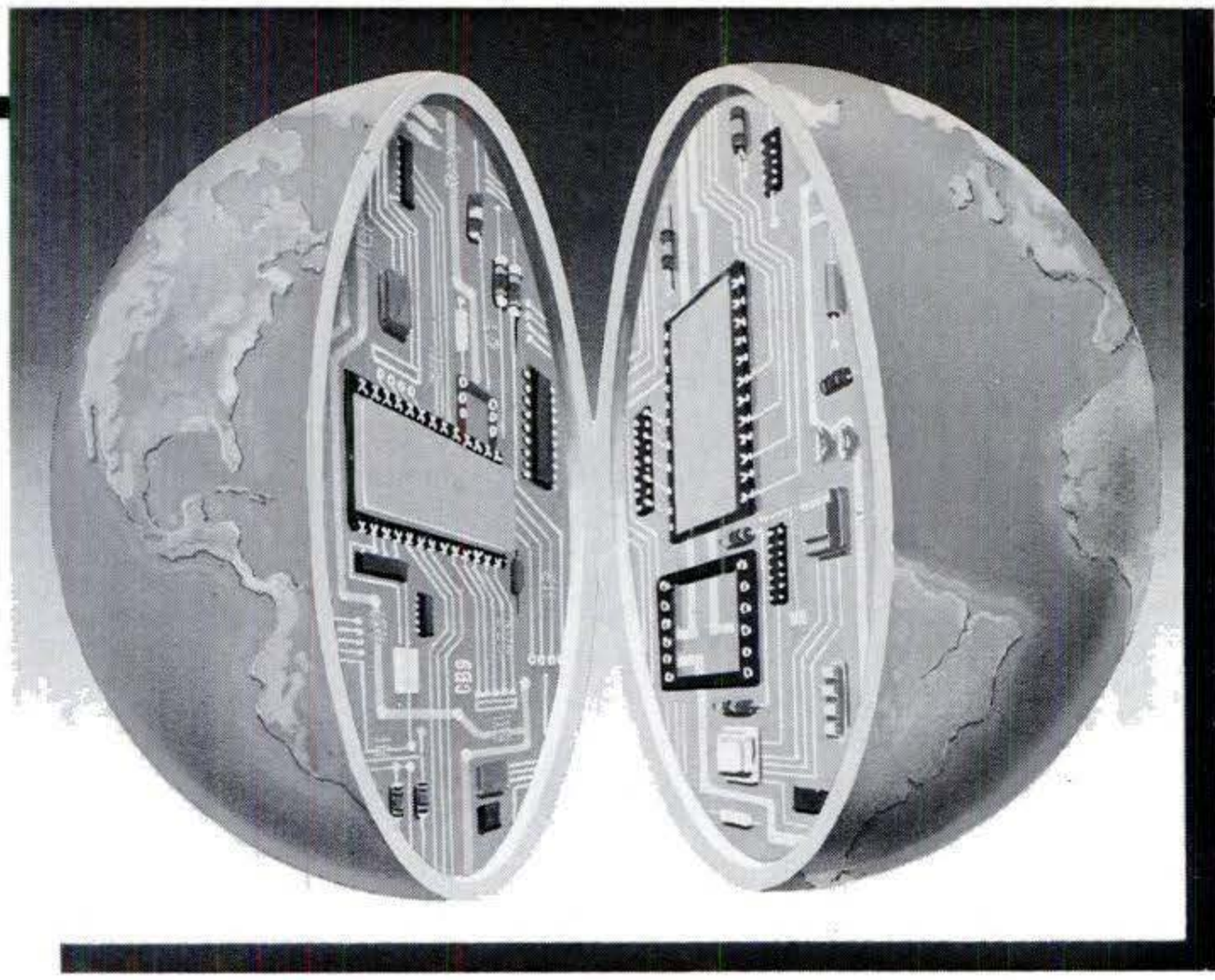

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No more phone book —if you live in France

To look up a telephone number, the French use computer terminals. This use of videotex may serve as a model for U.S. ventures.

By G. BERTON LATAMORE

DRAWING BY ROY DOTY

I turned on a small terminal connected to the telephone, dialed a number, and typed "mal de cœur" and the address of the Paris office I was sitting in. In seconds, the screen filled with information on several heart doctors located nearby. Next I entered the name of my host, Georges Nahon, purposely misspelling it. The computer corrected my spelling and gave me his home listing.

I was using the French National Electronic Directory, a unique service that is replacing telephone books throughout France. Instead of a phone book, homeowners can choose a free "Minitel" videotex (text data base) terminal—basically a keyboard, CRT, and smart modem. They can use the terminal to call up about 1,000 specialized videotex services—and the National Electronic Directory. Available nationwide, the directory holds all 25 million French phone listings and handles four million inquiries a month.

Three things make the computerized directory attractive to the French, says Nahon, managing director of Intelmatique, a branch of the government agency that runs the telephone system.

- It finds names of people anywhere in France.
- It has a simple command structure.
- It is updated daily.

Nahon admits that the massive terminal giveaway—the French government has already provided a million terminals at a total cost of around $250 million—is expensive. But so is printing annual telephone directories and providing directory service. "We hope to replace printed directories almost entirely in France," Nahon says.

Although most directory calls are free, there's a charge for each minute a call is made to the Electronic Kiosk—the digital telephone switch that connects the caller to the other videotex services. The charges, about $6 an hour, show up on the user's telephone bill. The income to the phone company is huge. In one month, the videotex network carried 3.5 million calls for 400,000 hours of use.

What are the French doing with their Minitels for all these hours? To find out I visited Funitel, which offers interactive electronic games and quizzes. Funitel is one of the two most heavily used services, with an average of 20,000 calls and 2,000 hours access time logged every day.

Trying out one of the most popular "games," I entered the date and place of my birth. In seconds, the screen displayed a complete astrological readout, including a detailed prediction of my short-term future. Other Funitel offerings include psychological questionnaires based on clinical tests. Answer the questions, and receive computer profiles of topics ranging from your dating preferences to your child's latent skills. There's also a unique computer-moderated chess program that allows two players from anywhere in France to play against each other.

This successful program led to another offering—electronic mail. To allow chess players to arrange games, Funitel provided an electronic bulletin board. It was immediately filled with lonely non-players looking for friends. Now Funitel offers a general communications service.

Why is videotex so successful in France? One reason: "The French see videotex as a complement to the telephone, not the newspaper," Nahon explains, "and therefore see it as a communications rather than an information medium." And Minitel users don't have to subscribe to each videotex service—they simply call the Electronic Kiosk. The French like this setup so much they use it even when it costs more. Funitel advertises subscriptions at a rate lower than the kiosk's—but no one buys them.

In the U.S., by contrast, users must subscribe to central data bases, such as CompuServe, The Source, and Viewtron [PS, Jan. '81], which offer many different services.

But the kiosk also keeps the independent French services competitive. "Suppose you have a news service," Nahon says, "and someone else develops a better one. The word gets around quickly, and everyone switches to the new service. You have to improve constantly to keep your users."

Summing up the French experience, Nahon comments: "We believe we have found a way to bring the benefits of computer communications into the home." Several U.S. videotex companies are studying the French experience—and at least two now provide a more accessible service. Both Shuttle Corp. (2569 152 Ave. N.E., Redmond, Wash. 98052), and CitiNet (490 Trapelo Rd., Belmont, Mass. 02178) offer advertiser-supported videotex free to anyone with a home computer. PS

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Amazing New Third Brake Light Can Save Your Life

Introducing the biggest safety breakthrough in the history of the National Highway Traffic Safety Administration (NHTSA).

Gov't approved Mandatory for 1986

Stringent government tests prove that the third brake light mounted at eye level reduces rear-end accidents by over 53%. The government is so amazed with these test results they are demanding all 1986 cars be equipped with this new third brake light. (These cars will be introduced in September of 1985.)

The NHTSA estimates predict that this light will prevent 900,000 rear-end collisions a year and 40,000 personal injuries a year. And when accidents do occur, tests show that personal injuries are reduced. Car damage and repairs are also reduced by almost 60%.

Here's why it works

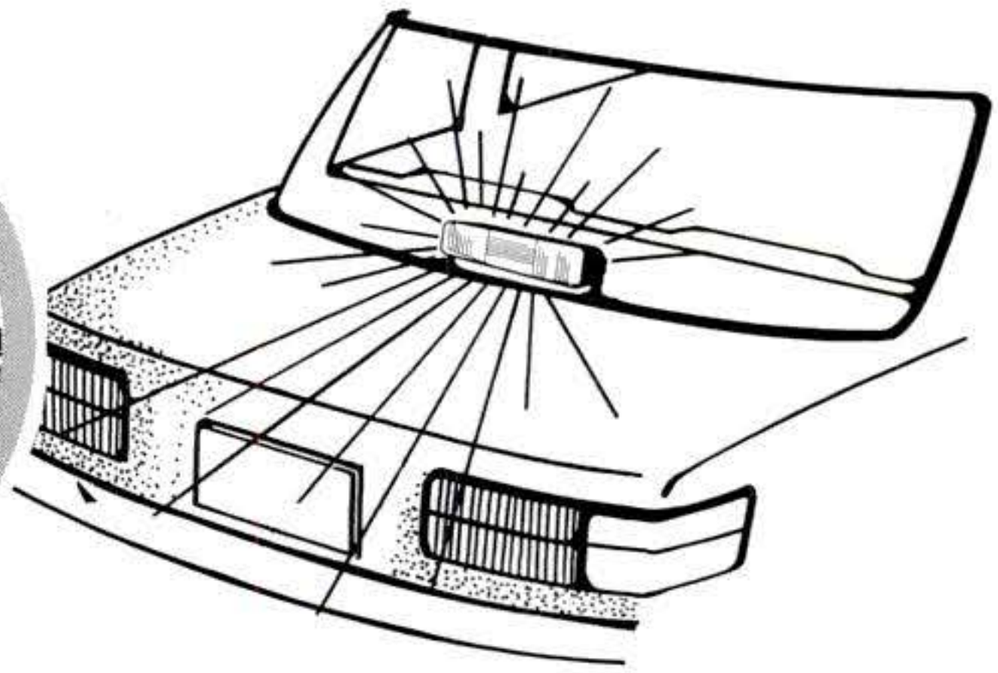
Mounted at eye level, the brake light is bright and easy to see because it shines directly into the eyes of the drivers in the second and third cars behind you. Also, since the light comes on only when you brake, it can't be confused with turn signals or tail lights.

Reduce rear-enders

The third brake light can prevent painful whiplash injuries, remind tail-gaters to back off, and gives the driver behind you better depth perception, day or night.

Check with your insurance company. They may offer a discount for these lights.

Amazing results — your chance of a rear-end accident is reduced by over 53%.



Mounted at eye level, the third light is easy to see.

Exclusive Design

The versatile design of our light comes complete with everything you need — so it fits every kind of car. The patented bulb assembly snaps out for easy bulb replacement. The contemporary style has a low profile — so it looks good on all vehicles.

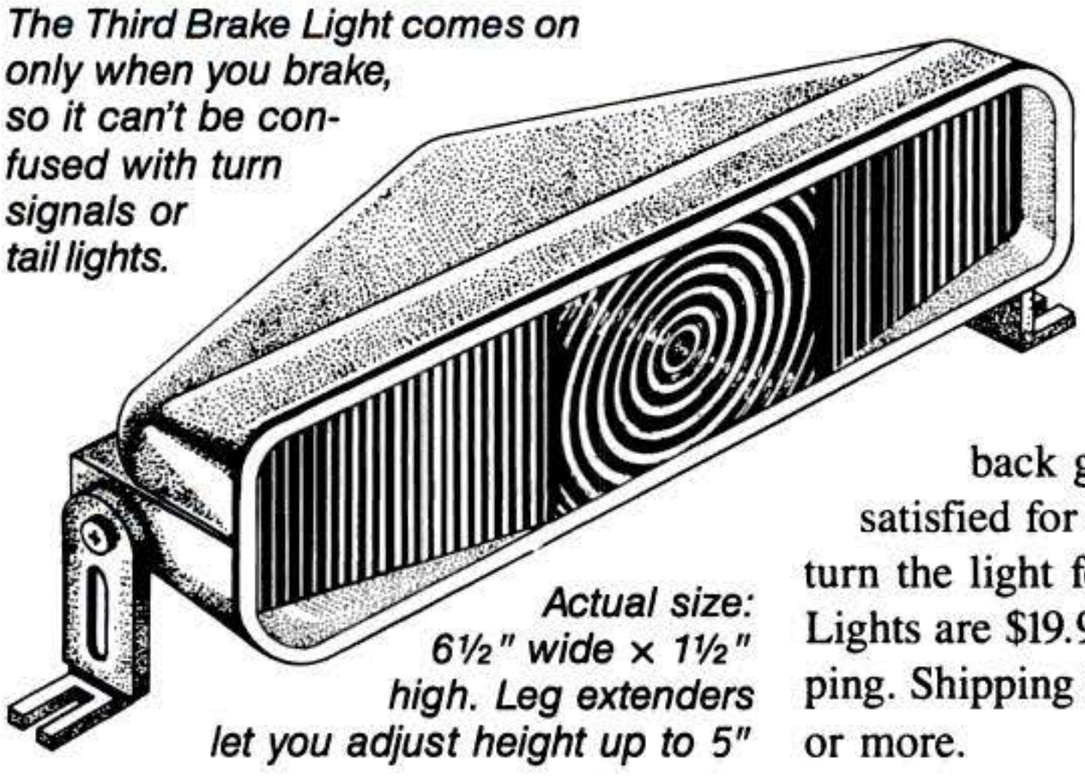
This American made light meets all Federal Motor Vehicle Safety Standards (FMVSS) including Federal Safety Standard #108.

It's easy to install

The eye level brake light mounts inside your rear window — like the new cars, where it is protected from weather, car washes, body damage and theft.

We offer two assembled models — one for American cars and one for foreign cars. Pivoting legs (with leg extensions) make it adjustable to fit all sedans, hatchbacks, station wagons and pick-up trucks. Good instructions and snap-on wire connectors make this a job you can do with a screwdriver and pliers in just 20 minutes.

The Third Brake Light comes on only when you brake, so it can't be confused with turn signals or tail lights.



Actual size: 6½" wide × 1½" high. Leg extenders let you adjust height up to 5"

Money-back Guarantee

Our lights are backed by a one year manufacturer's warranty and our own 60-day money-back guarantee. If you are not satisfied for any reason, you may return the light for a prompt full refund. Lights are $19.95 each, plus $3.00 shipping. Shipping is FREE with orders of 2 or more.

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Order today

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All orders are shipped promptly. Fleet prices available. Dealer inquiries welcome.

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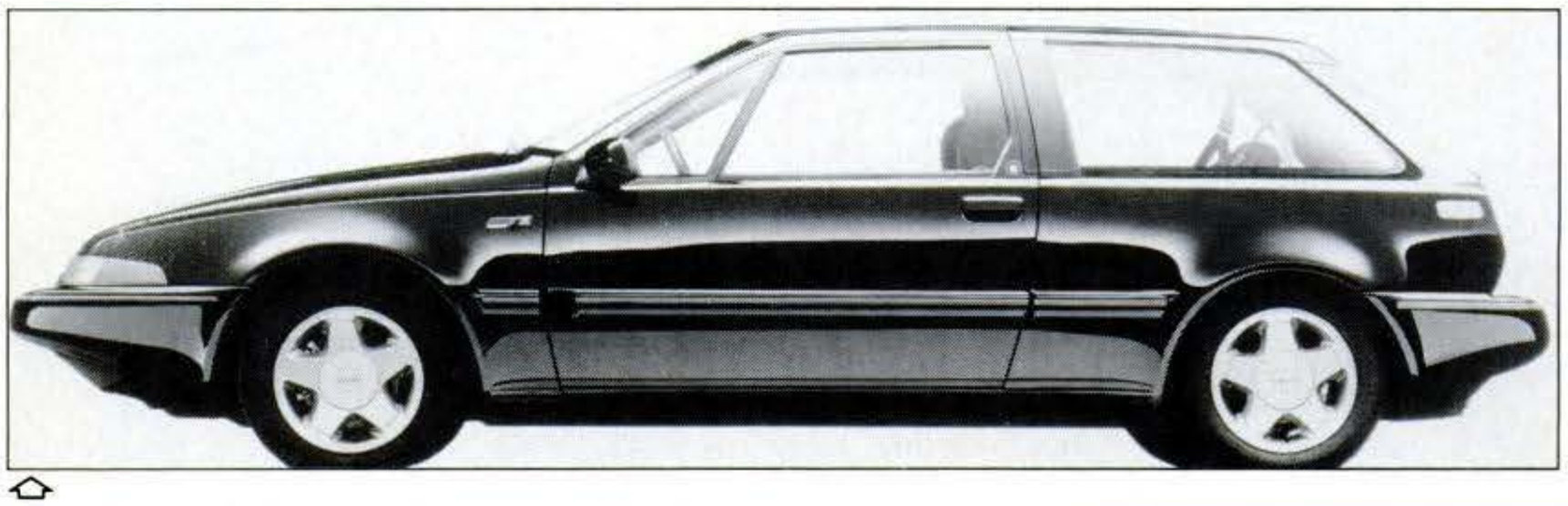
What's New

products/technology

Travel watch

If this is Paris, what time is it? Match a city code on the band to the dial on its $790 Airline watch, says Heuer Time & Electronics Corp. (420 S. Springfield Ave., Springfield, N.J. 07081). An extra 24-hour hand on the GMT model can be set to a third time zone.



Front-drive coupe

A sleek hatch body for Volvo's 480 ES sports coupe replaces the boxcar look. The car has a 1.7-liter 109-hp Renault engine with electronic fuel injection and ignition. All wheels have disc brakes. Pop-up headlights improve aerodynamics. It's due in the U.S. as an '87 model.

Ferry to go

A flip-open bow can disgorge 600 cars from Finland's giant 37,800-ton *Mariella*. The ferry and hotel will accommodate 2,500 passengers between Sweden and Helsinki. There are 830 cabins, two discos, a casino, and nine restaurants. Four engines deliver 36,000 hp and 22 knots.

Business jet

A full-size mock-up of a four-passenger business jet by Williams International (Walled Lake, Mich.) features forward-swept wings and nose canards. Two Williams 1,800-lb.-thrust FJ44 fanjets (inset) power it. Composites reduce drag and limit its weight to 10,000 lbs.

Message key pad

Dial British Telecom's Voicebank service and tap your ID number into a pocket-size key pad: Tones sent to a computer let you hear or leave messages. Up to seven 25-sec. messages can be stored for 12 hrs. A radio-paging service can beep you as messages arrive.

Sporty compact

Daihatsu Motor Co. says its sporty new Charade offers compact-car economy plus the style and performance of larger, more expensive cars. Three- and five-door models with three-cylinder one-liter gasoline or diesel engines and turbo options are slated for U.S. sale next year.

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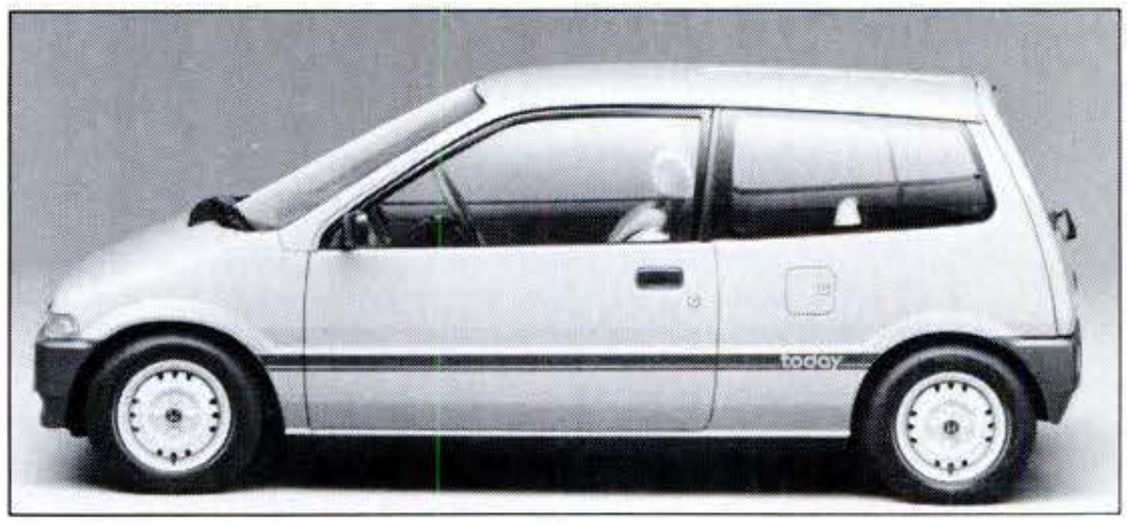
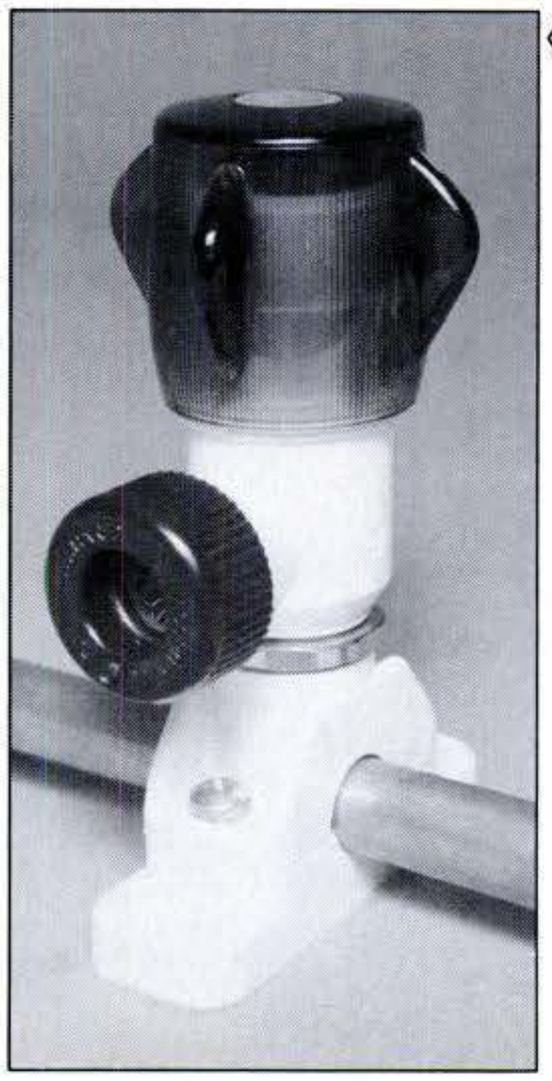
Night bomber

An infrared navigation and targeting system under test on F-15 Eagles gives the fighter a dual role as a bomber, says McDonnell Aircraft (St. Louis, Mo.). Two pods beneath air inlets on upcoming F-15Es will carry advanced electronics for pinpoint bombing at night.



Micro and mini

Honda unveiled its Today microcar (left, top), and Mazda rolled out its 323 model (left, bottom). The pint-size four-passenger Today has a two-cylinder 31-hp engine. Vehicle length is 10.5 ft., with 5.4 sq. ft. of luggage space. The Today won't be sold in the U.S. Mazda's 323 replaces the subcompact GLC. "A key objective in redesigning the 323 was a reduction in noise, vibration, and harshness," project manager Masaaki Kono told PS Associate Editor Jack Keebler during a recent test drive in Japan. Fuel injection and a tuned intake manifold have boosted the 323's 1.6-liter four-cylinder engine's output to 82 hp.



Add-on tap

Plum-In lets you tap into exposed water pipes for an added outlet. Just clamp the plastic base around a ½-in. copper pipe to pierce and seal a connecting hole. The self-plumbing tap includes a shut-off valve. Uni-Tubes Ltd., 189 Bath Rd., Slough, Berks SL1 4AR, England.

Tilt-wheel tractor

Cutting grass on hills in a big way? Slopemaster 662 tractors remain stable on slopes—up to 30°—because the chassis and wheels tilt left or right. The engine is a four-cylinder 76-hp diesel. Cutting width adjusts to 72 or 90 in. DLR, Box 18945, Fort Worth, Texas 76051.

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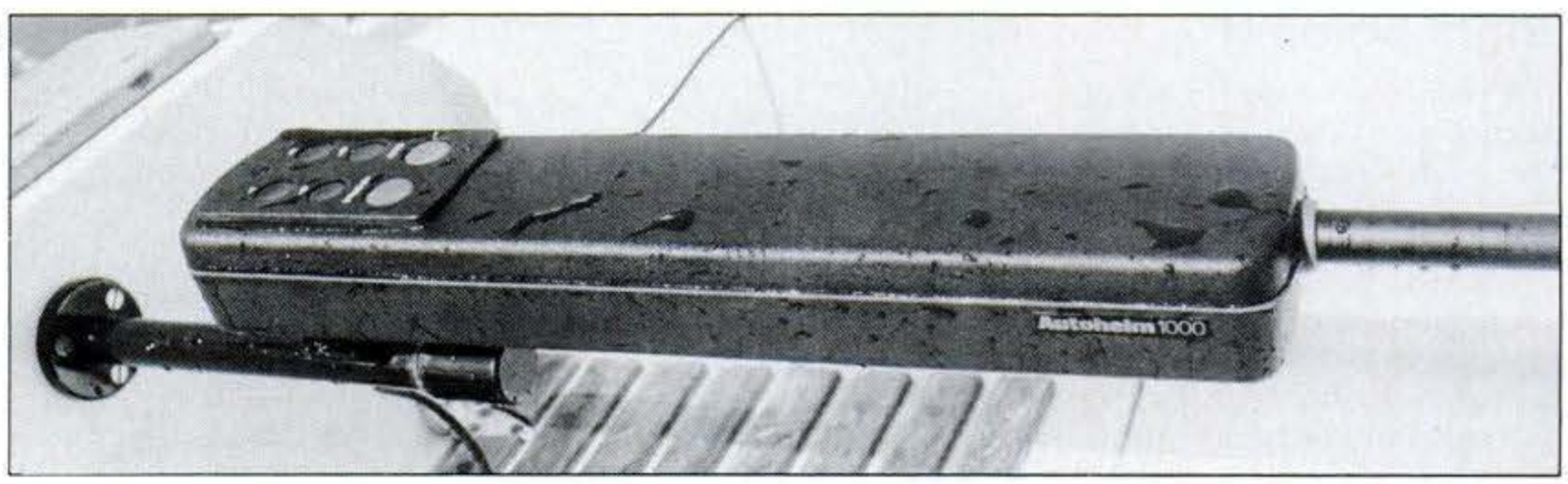
What's New *in Recreation*

BY STUART F. BROWN

Hot cats

One sailor can race, or two or three people can cruise in the Hobie 17. The high-performance catamaran has Mylar plastic-film sails, an aluminum-and-fiberglass mast, and spring-loaded retractable centerboards, says Hobie Cat (Box 1008, Oceanside, Calif. 92056). It's $3,685.

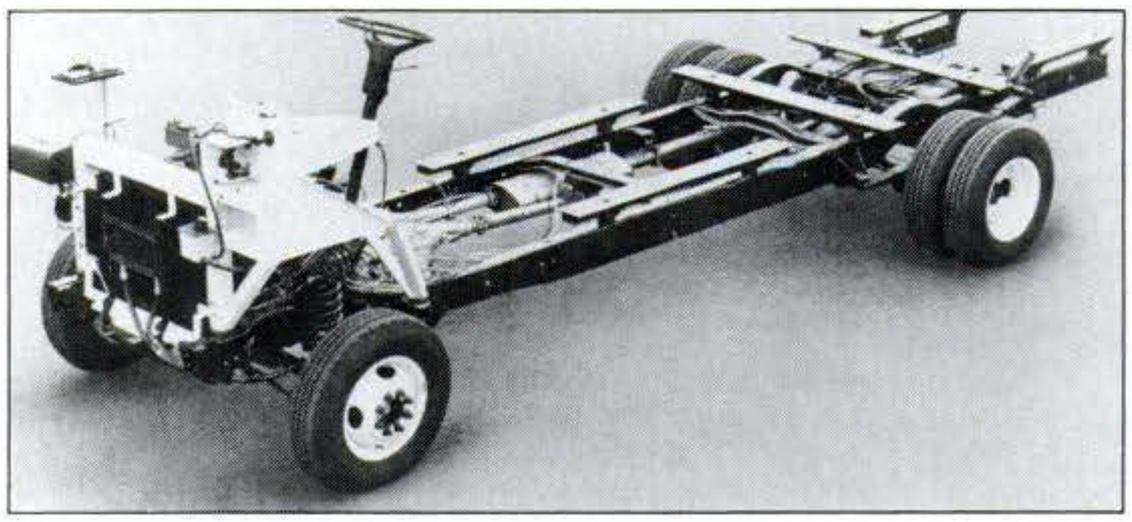


Auto sailing

Autohelm 1000, an autopilot for small sailing yachts, is controlled by a flux-gate compass. Slight variations in Earth's magnetic field are converted by microprocessor into commands to the mechanical tiller. Nautech Ltd., Anchorage Park, Portsmouth PO3 5TD, England.

Tubing first-class

Put yourself in prime position for lake and pond fishing—inexpensively—with Float Tube, says Browning (Rte. 1, Morgan, Utah 84050). Three storage pockets can hold tackle, lunch, etc. A nylon seat with a quick-release strap positions the angler low for stability. $92.



Class-A chassis

Aerodynamic 11,500-lb. class motor homes will fit nicely atop its new 158-in.-wheelbase chassis, says Ford. The engine is set far forward in the frame, allowing two steering locations and easier entry and exit. Ford Truck Operations, Box 2053, Dearborn, Mich. 48121.

Mini motor home

After they've showered, dined, and listened to some tapes, three or four adults may feel like hitting the hay. They can do all of the above in this 18-ft., $22,000 motor home, according to Scamp Eveland's (Box 2, Backus, Minn. 56435). Underneath is a Ford Ranger V-6 chassis.

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—"Outstanding! Best cigars I have had since returning from overseas," wrote H. E. O., of Columbia, SC

—"I am very impressed with the mildness and freshness of the sampler you sent," said J. J. M., of Lincoln, IL

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What's New *for Your Car*

BY JACK KEEBLER

Magnetic ski rack

Large magnetic plates attach this ski rack to your car's roof. That makes it perfect for new vehicles that don't have conventional rain gutters. It's been tested without failure at up to 170 mph, claims Velm (6400-F Stapleton Dr. S., Denver, Colo. 80216). Price: $59.95.

Tire gauges

Mount four of these push-button gauges on your tire's valve stems for easy pressure checking (20 to 38 psi). Ferran & Co. (79 Harriman Rd., Irvington, N.Y. 10533) claims accuracy to ±1 psi. Air can be added or released without removing them. Four gauges cost $15.

Talking alarm

Voice Alarm shouts your prerecorded alarm message, flashes the headlights, and sounds the horn, says Voice Technology Intl. (3900 E. Whiteside St., Los Angeles, Calif. 90063). Keyless, it automatically arms itself 15 seconds after the last door is closed. Price: $139.

Light tool box

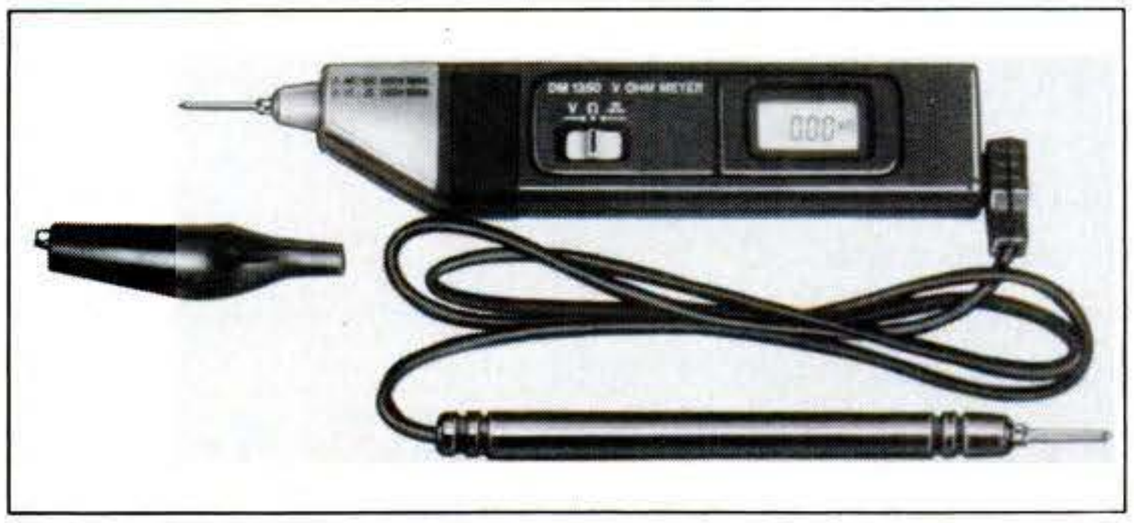
Take the weight out of hauling your tools around with this polyurethane tool chest from Sears. Blow-molded, with rigid double-wall construction, it's 22 by 9 by 10 in. high, watertight, and rustproof. Sears says it resists cracking, even when exposed to low temperatures. $40.

Clip-on light

Black & Decker's Car Work Lite works from a 12-V cigarette-lighter receptacle. A swivel head, a padded clamp that fits objects up to 1¾ in. wide, and a 12-ft. cord make positioning the light easy. The bulb provides up to 2.7 candlepower. $18.

Tiny tester

Snap-on's MT135 AC/DC voltmeter-ohmmeter-continuity tester comes with a storage case, probe, alligator clips, and batteries. It also has LCD readout, data hold, and automatic zeroing, and reads voltage up to 500 AC or DC with input impedance of 10 megohms. $80.



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Save Gas, Save Engine with **'POLY'**

The following introduces one of the most fully tested and credentialed gas saving, friction reducing engine treatments ever to reach the market!

WHAT IS POLY? "Poly" is short for polytetrafluoroethylene (TFE). It is the slipperiest substance known to man **(1981 Guiness Book of World Records, p. 188).** The PetroLon Corporation, makers of Slick 50, has invented a way to permanently bind this slippery chemical to your engine with one treatment. All you do is add one quart of Slick 50 to your oil during oil and filter change. By reducing engine friction, Slick 50 increases gas mileage and horsepower and reduces engine operating temperature thus causing your oil and engine to last longer. Just as important, it reduces metal wear, defraying costly overhauls.

HOW DO I KNOW THIS ISN'T A FRAUD? Slick 50 has some very impressive credentials. The **"Consumers Digest"** magazine (March/April 1982, p. 35) states "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage. . . . Slick 50 does exactly what Petrolon claims it does." Researchers at a **nationally respected research laboratory**, after applying a powerful ultrasonic cleaning process to a Slick 50 treated engine part, were surprised at its permanence. They stated, "We actually expected the PetroLon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

The **Federal Aviation Administration** has fully accepted a similar product- Slick 50 Aircraft Treatment (F.A.R. #33.49). An FAA test simulating 1400 hours of engine use (equivalent to about 70,000 miles on a car) showed almost zero engine wear!

"Dune Buggies and Hot VW's" magazine, April 1983, p. 70-71, records the results of their one year testing of Slick 50. "We can indeed say scientifically that Slick 50 does work and that it does reduce engine wear!. . . . for the price of one treatment when compared to engine rebuild, we feel you'd be money ahead using Slick 50." The senior engineering researcher at the **University of Southern California** in San Diego stated this, "Slick 50 does increase horsepower and decreases fuel consumption in tests done at the university." The **Space Shuttle Columbia** uses the chemical "poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

Perhaps the most dramatic of all is a

torture-test overseen by the **Automotive Services Council for Pennsylvania** and shown on television station WTVE. Three cars with between 75,000 and 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle and the cars were driven without the oil plugs for about a half hour. The water temperature never rose and the engines sustained no apparent damage. There are many more tests available. If you are still skeptical, send $2.00 to defray printing and postage costs and we will send you additional, more detailed, test information, etc.

HOW DO YOU TREAT AN ENGINE? Very simply. Just before oil and filter change, add engine flush (sent free with each order) to clean out your engine. Let your engine idle for 5 minutes. Then drain your oil, change filter and add the proper amount of oil less one quart. Add one quart Slick 50, drive for 30 minutes, and leave it in the crankcase for 3,000 miles. As the engine operates, the oil carries the "poly" between the parts where it is burnished into the pores of the metal. Once impregnated it is permanent, so **you do it only once**, not each time you change oil. One quart of Slick 50 will treat all standard 4, 6 and 8 cylinder gasoline and diesel engines.

WILL IT WORK WITH MOST OIL? Yes, Slick 50 will work with all petroleum based oils and all synthetics compatable with petroleum based oils.

WHAT ARE THE BENEFITS OF SLICK 50? Your actual benefits in percentages may vary, depending on the kind of driving you do, vehicle condition, etc. By reducing friction, Slick 50 does all of the following: it **increases gas mileage**. It **increases horsepower** -- small economy cars and large RV's really need this. It makes for **easier starting** (important in cold weather). It **reduces operating temperatures**, thus increasing the lubrication and life of your oil and your engine. Since lubricating lead is being removed from gas and unleaded gas is poor in lubricating qualities, the **extra lubrication of Slick 50 on valve stems and guides is very valuable**. Last, but not least, the drastic reduction in engine wear **defrays or eliminates costly overhauls** which can save you over $1,000. Slick 50 eliminates the "lubrication starvation" that all cars experience when first started before the oil has a chance to circulate. Up to 90% of the wear on a car can be caused by this lubrication starvation. You receive all of these benefits for **less than the cost of two tanks of gas** ($39.95).

WILL SLICK 50 HARM MY ENGINE OR AFFECT MY WARRANTY? No! Slick 50 is suspended in an excellent grade of petroleum oil which meets or exceeds every manufacturers engine warranty requirements. In addition, this oil carries an API (American Petroleum Institute) service classification SF-CC-CD.

DEALERSHIPS ARE AVAILABLE.

OTHER SLICK 50 PRODUCTS available are Gear Treatment (manual transmission, etc.), 2-Cycle Engine Treatment, Grease, Ultra 9 Oil, Fuel Conditioner, and Fabric Protector. Free information is sent upon request.

EASY TOLL FREE NUMBER. Since Slick 50 is **"too too Slick"** for engine friction, our toll free number is 1-800-22-SLICK (that is, 1-800-227-5425).

Free engine flush sent with each order. Free shipping with orders of 2 or more.

For purchase or further information call toll free 1-800-22-SLICK, (in Colorado, call 1-303-667-1715) or send to: FORT MORGAN SLICK 50, 407 Del Rio Road, Berthoud, Colorado 80513.

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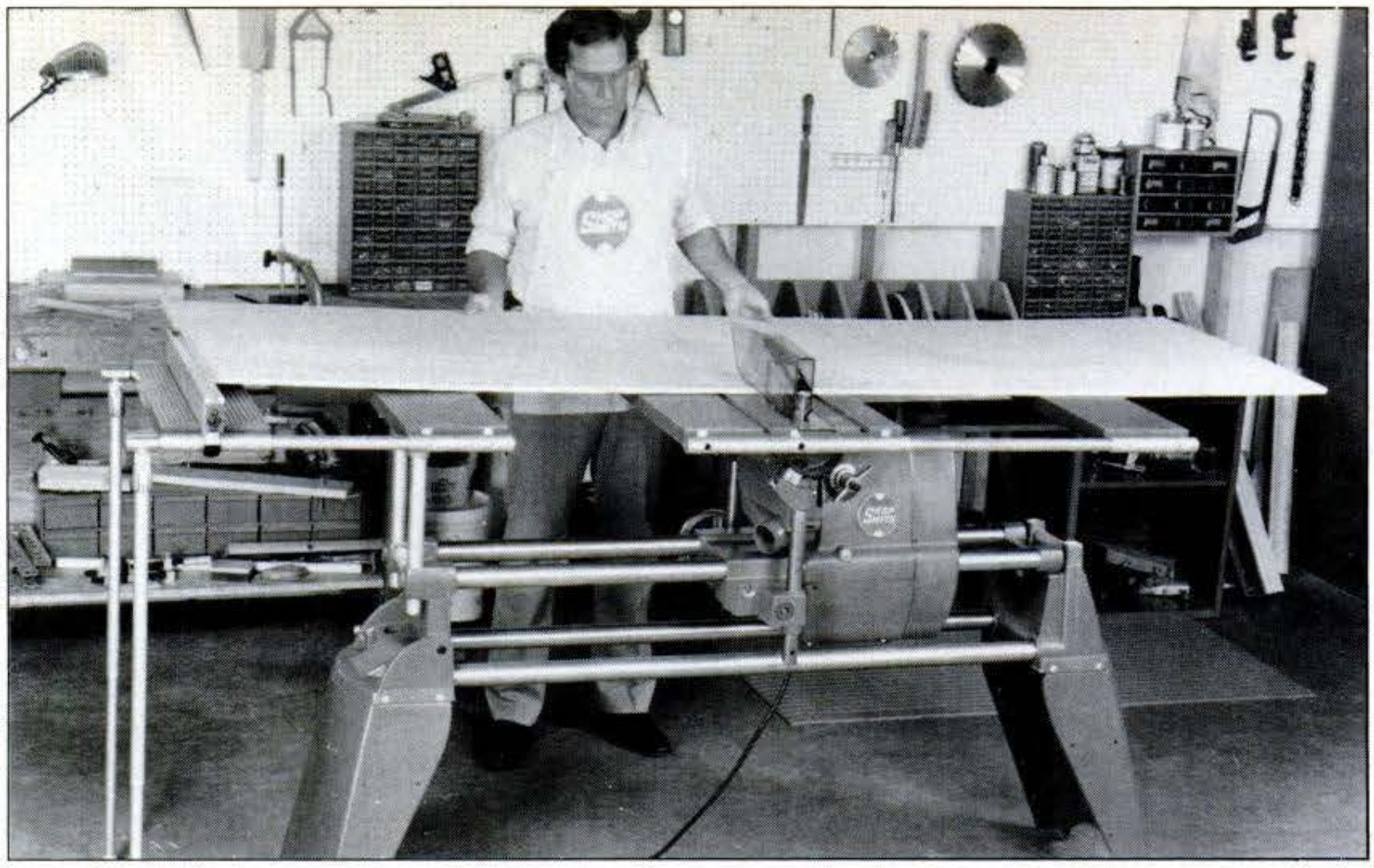
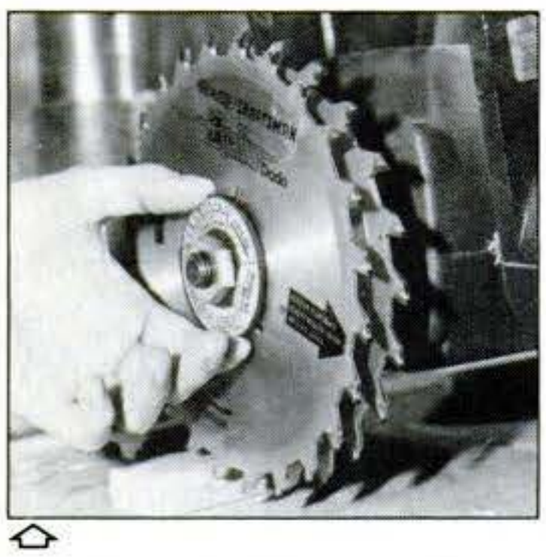
What's New *in Tools*

BY V. ELAINE GILMORE



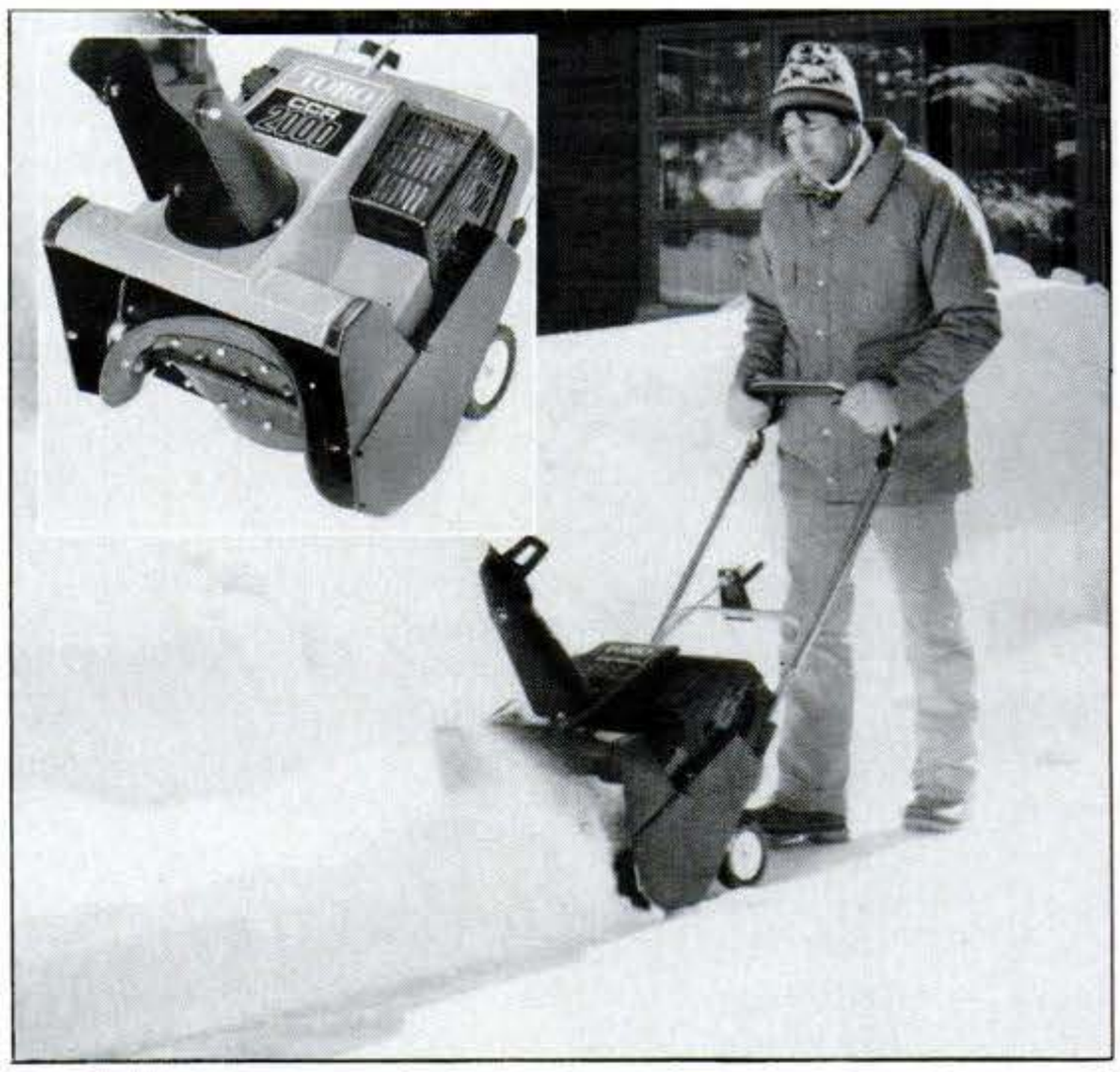
Big-table tool

Shopsmith's latest multipurpose tool, the Mark V Pro, comes with two add-on tables that extend the work surface to 109 in. The $1,599 Pro has superior capabilities as well, says Shopsmith (750 Center Dr., Vandalia, Ohio 45377). A kit to retrofit a standard Mark V is $450.



Dial-a-dado

The twin-blade Craftsman dado set can be adjusted—while on your saw—to cut dados from 1/4 to 13/16 in. wide. A simple twist of the collar does it. The 8-in. blades have 48 diamond-sharpened carbide tips. The set ($100 in Sears' tool catalog) fits radial-arm or table saws.



Drift buster

Unique bell-curve blades (inset) on Toro's single-stage CCR-2000 snow thrower ($480) dig out 13-in. drifts, then throw the snow up to 30 ft., equalling the performance of costlier two-stage models, says Toro. The no-clog 210° swiveling chute is controlled by a hand crank.

Field guide

Take along two compact tools, and you can sharpen your saw chain in the field, claims Combined Technologies (Box 575, Bellows Falls, Vt. 05101). The Pro-Filer ($12) is a guide for round files (5/32, 3/16, and 7/32 in.); the Sure-Grip ($9) is a vise to steady the saw. Add $2.25 for shipping.

Adjustable heat

With a temperature range of 125° to 1,000° F and a two-speed fan, the Thermostrip 3200 heat gun is good for stripping paint, shaping plastic, soldering (via a special nozzle), or lighting charcoal. The 1,350-W gun is from Emhart Corp. (Box 3716, Reading, Pa. 19605). $50.

Batt cutter

Put batts in your attic with ease with Groove-V-Guide from Raynes Enterprises (Box 21077, Eugene, Ore. 97402). The tool slips over a 2 × 4 and squeezes the insulation batt against the board. You run a utility knife along a groove in the guide to cut the insulation. Price: $15.

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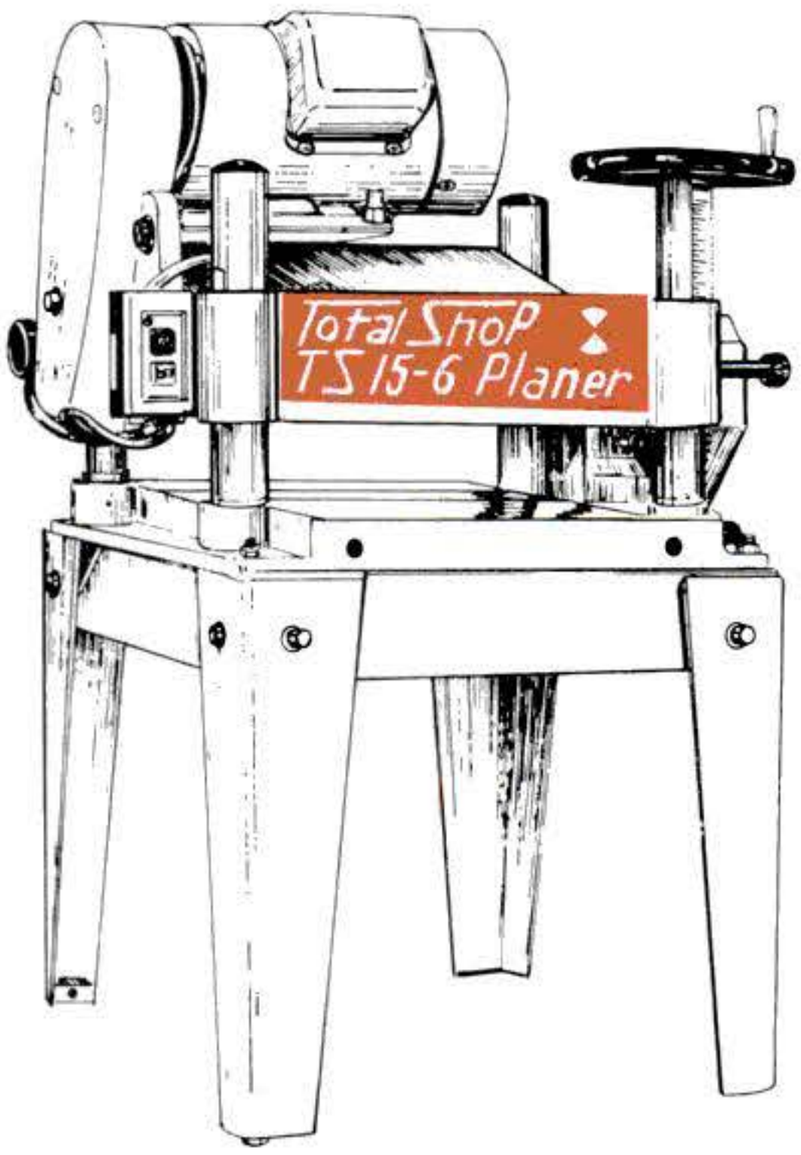

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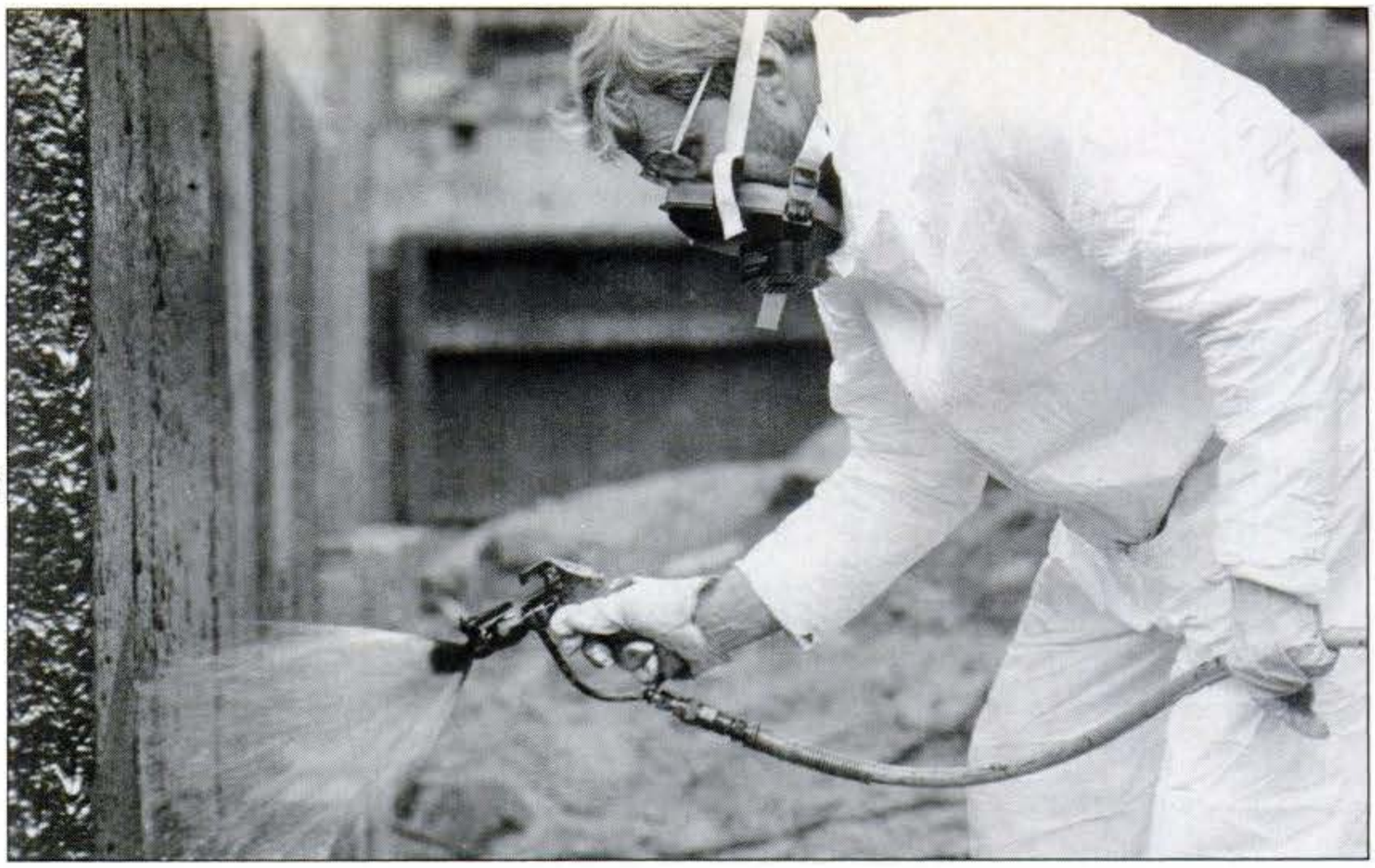
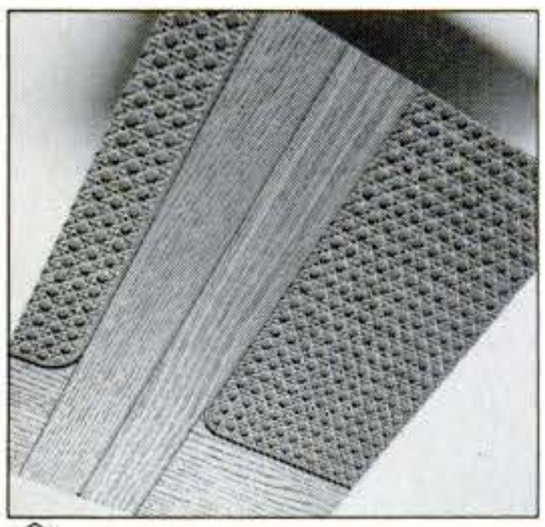
What's New *in Home Improvement*

BY SUSAN RENNER-SMITH



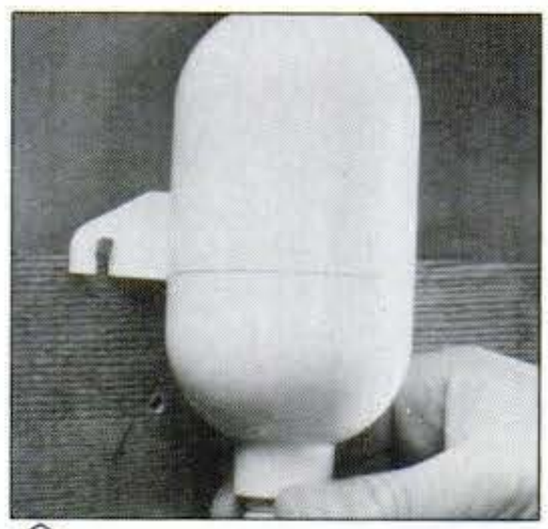
Waterproof coating

Tuff-N-Dri exterior spray-on coating wraps basements in a seamless membrane. Unlike thin "damp-proof" coatings, it stretches, sealing cracks that form as the house settles, says Owens-Corning Fiberglas (Fiberglas Tower, Toledo, Ohio 43659). It has a 10-yr. guarantee.



Textured panel

Three cane inserts add visual interest to Oak and Cane Design hardboard paneling. The panel's bottom third has a narrow-groove textured oak finish. The $19 panels (section shown) are effective as accent walls. Masonite Corp., 29 N. Wacker Dr., Chicago, Ill. 60606.



Plumbing muffler

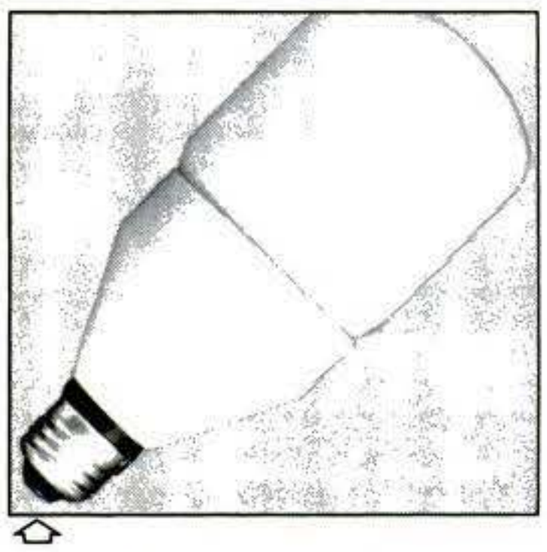
Crash, bang! Surging water can break pipes. Two-chambered Water Hammer Muffler has an inner balloon-like bladder to contain rushing water and an airtight outer chamber to absorb the impact. Genova (Box 309, Davison, Mich. 48423-0309) makes the $12 muffler.

Cheaper light

The Caretaker's rotating lens adjusts to illuminate the same size area as do two 150-W incandescent spotlights. But the $125 plastic fixture uses a 50-W high-pressure sodium lamp that gives 15% more light, says Crouse-Hinds Lighting (Box 824, Vicksburg, Miss. 39180).

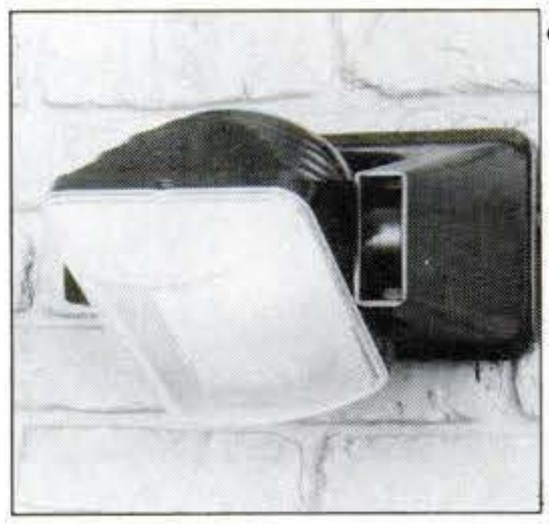
Semi-solid paint

Paint the ceiling in a suit: Sears' Ready-to-Roll semi-solid paint won't drip or splatter. Its custard-like consistency liquefies under roller friction. The no-mix latex flat paint comes packaged in a $16 ⅔-gal. plastic tray. One-coat coverage is guaranteed for 10 yrs.



Efficient bulb

Two tiny folded fluorescent tubes and a ballast hide inside the 7-in.-long Lux Paq-20 lamp. The 20-W lamp lasts 12 times longer and costs 73% less to burn than the 75-W incandescent it replaces, says Lite-Tronics (5317 W. 123 St., Alsip, Ill. 60658). Price: $18.



Door closer

Is your heavy front door often left wide open? The Doorman Power Plus automatically shuts 85- to 100-lb. wood and metal doors. Like the original, the $35 heavy-duty version has a model with a "hold-open" setting. Ryobi America Corp., 1158 Tower Lane, Bensenville, Ill. 60106.

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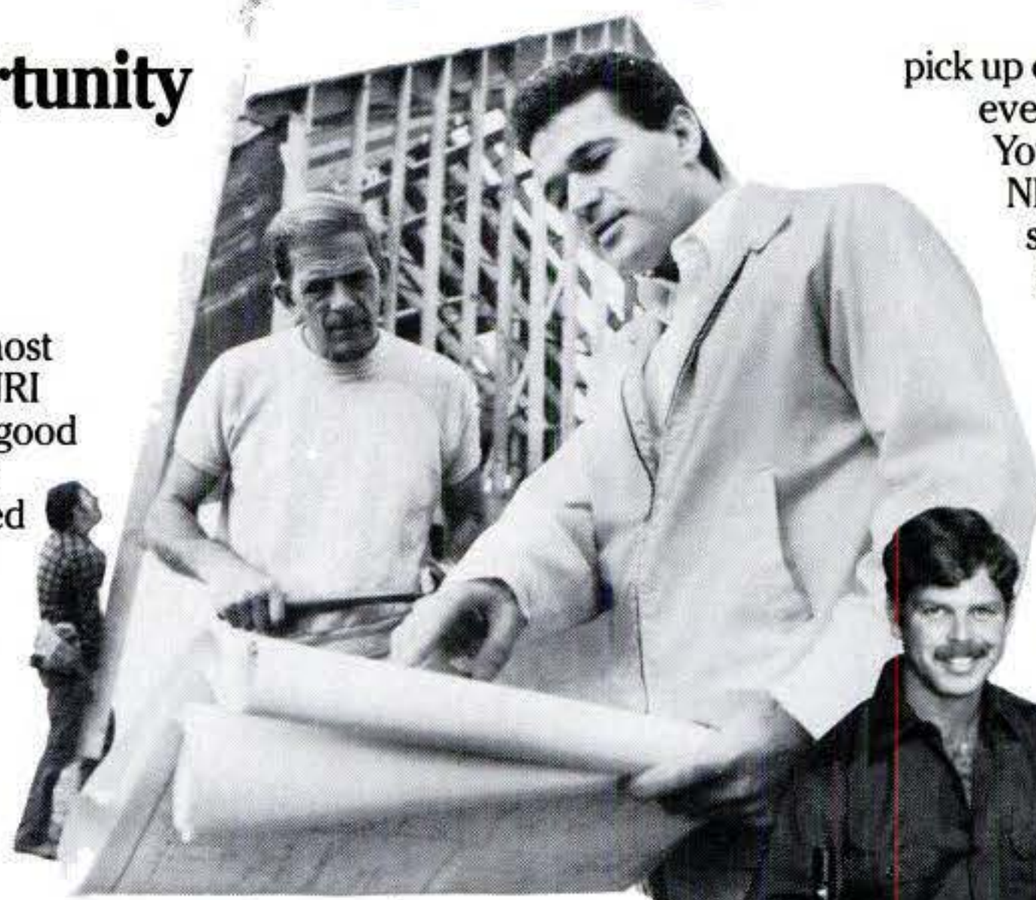

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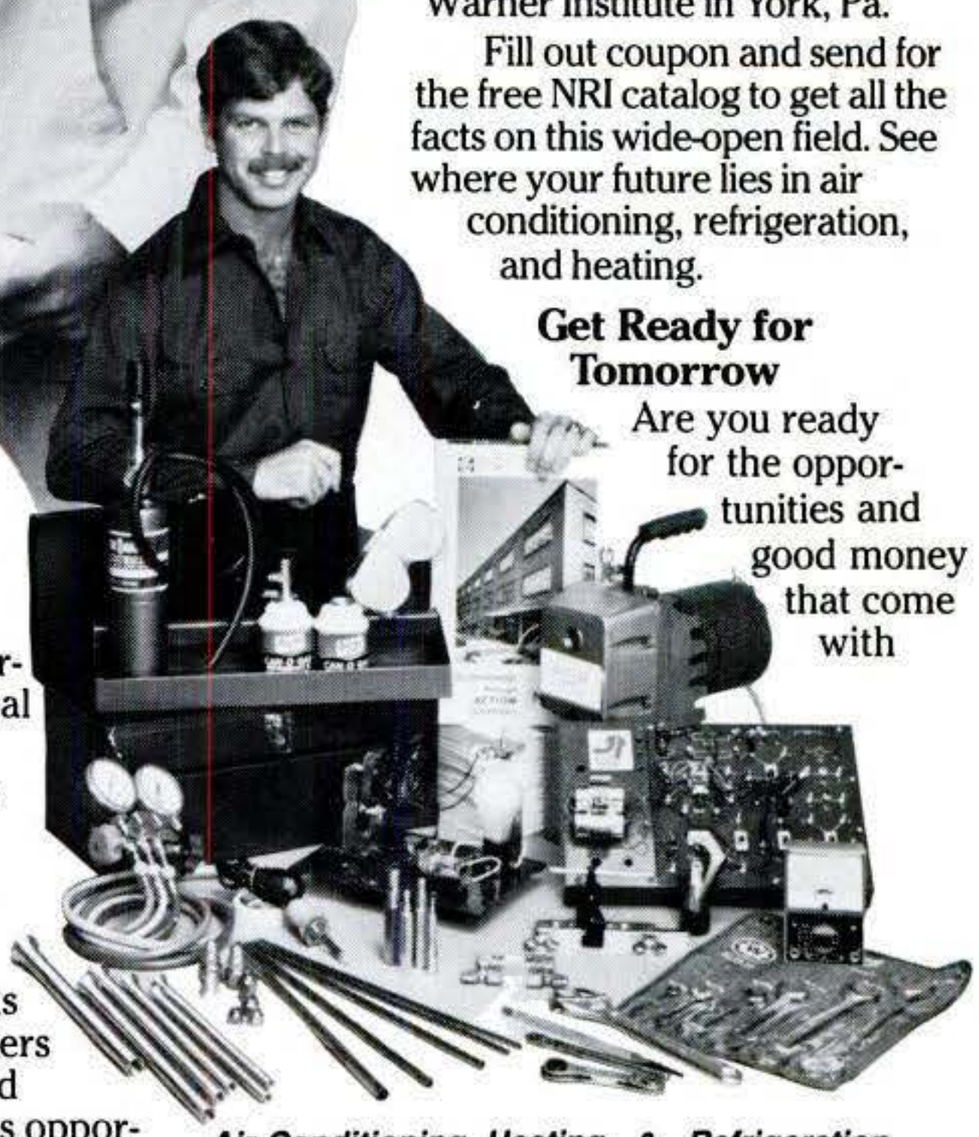

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What's New
in Electronics

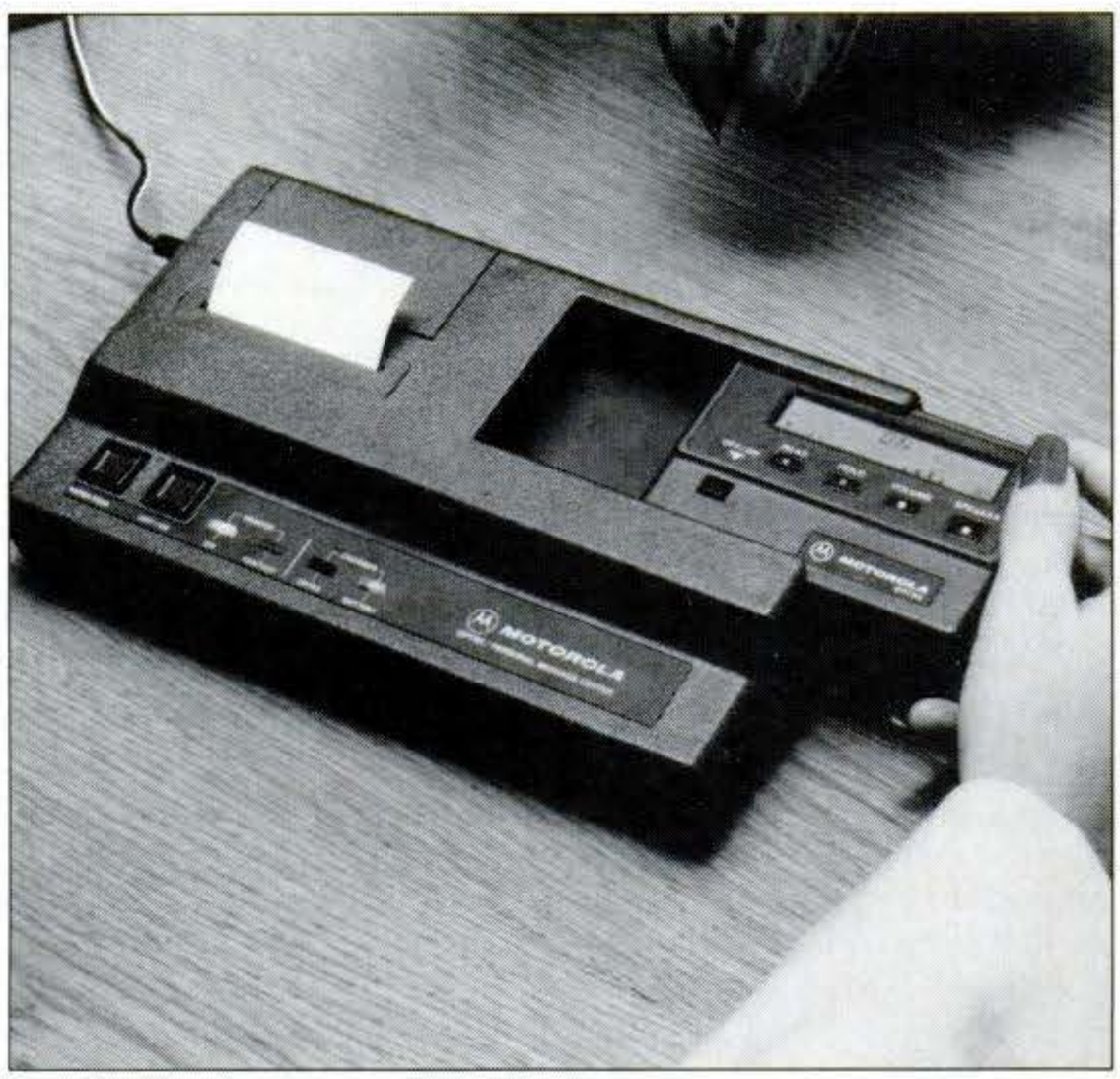
BY WILLIAM J. HAWKINS

Ready for work

Kaypro's MS-DOS desk-top computer includes two disk drives, 256 kilobytes of memory (expandable to 640K), serial and parallel peripheral connections, a 12-in. green-phosphor display, and software for programming, telecommunications, and word processing. $1,595.

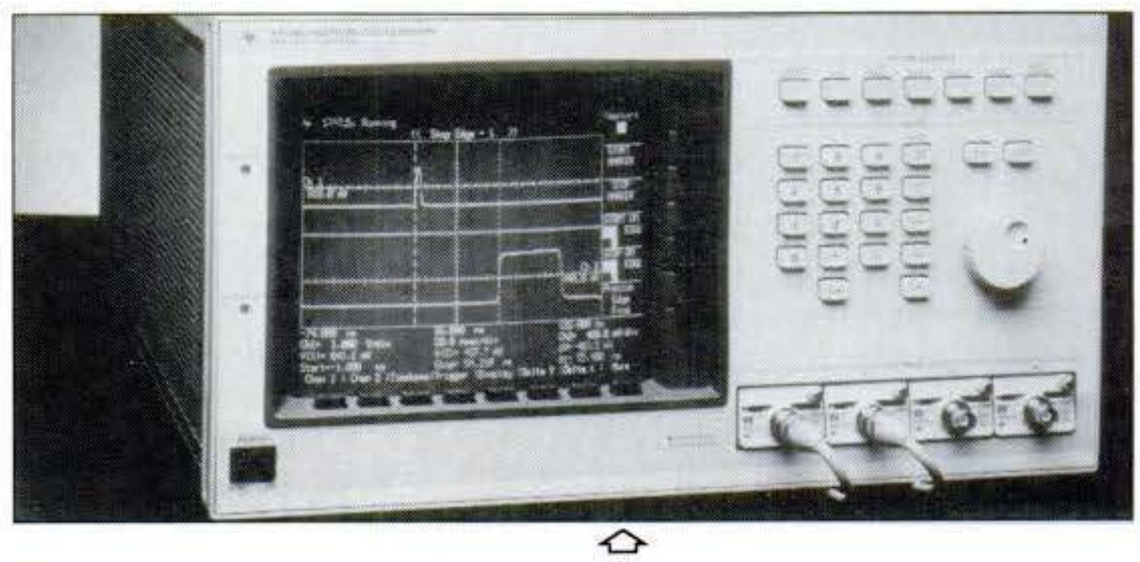
No-cord headphones

There are no wires connecting the headphones to your audio system. Instead, music is sent via infrared light from the transmitter at the hi-fi to the headphones up to 35 ft. away. Made by Nady Systems (1145 65th St., Oakland, Calif. 94608), the complete system is $120.



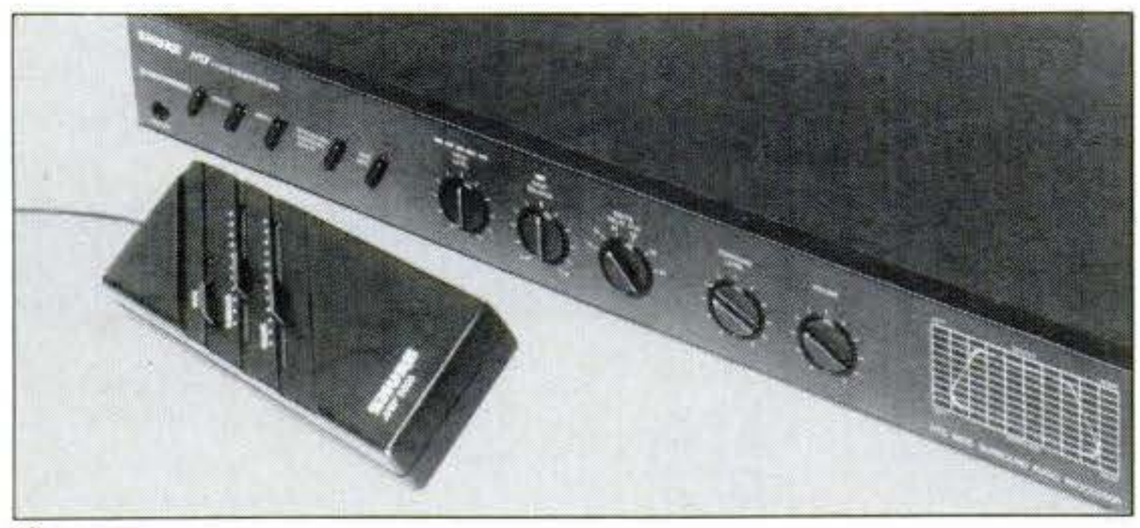
Pager-printer

While on the go, keep the $400 OPTRX Display Pager in your pocket. When you get to your destination, put it in its desk-top stand. This charges the pager's battery; a built-in printer puts all messages on paper. Motorola, 1301 E. Algonquin Rd., Schaumburg, Ill. 60196.



Color scope

The Hewlett-Packard 541-10D digital oscilloscope measures frequencies up to one gigahertz. And to display multiple data or wave forms, it adds color: Up to seven different colors can be shown at once from a selection of 4,096. Made for professional use, it's $21,000.



Surround sound

Add rear speakers and the Shure sound decoder to your video system. Result: The $600 HTS 5000 decodes multichannel Dolby stereo encoded on video cassettes and discs. You hear main audio tracks from the front and fill-in background audio from the rear.

Digital-TV maker

Get the features of a digital TV on any set by attaching the MV1001 converter to the antenna terminals. The box adds picture within a picture, freeze frame, remote control, and stereo audio. It's $399. MultiVision, 46127 Landing Pkwy., Fremont, Calif. 94538-6407.

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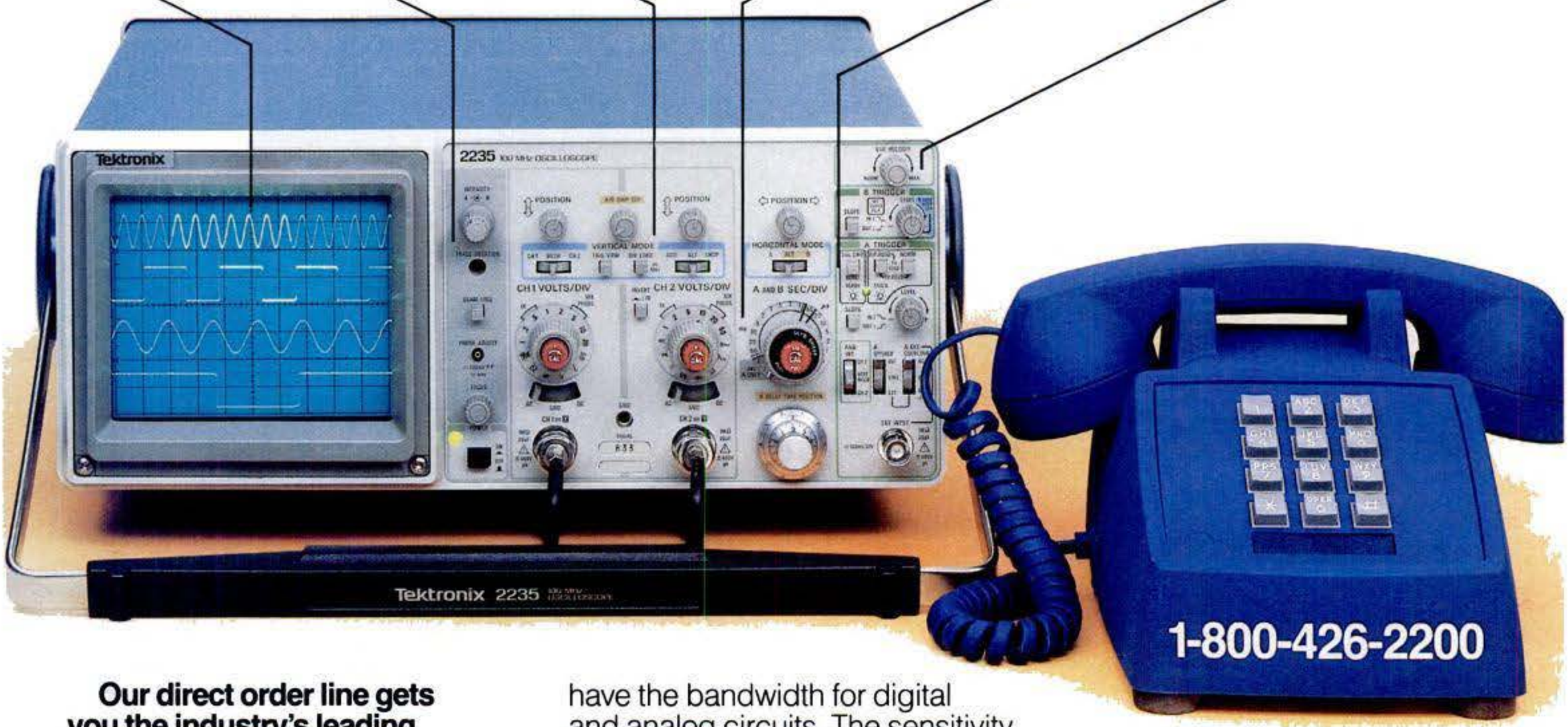

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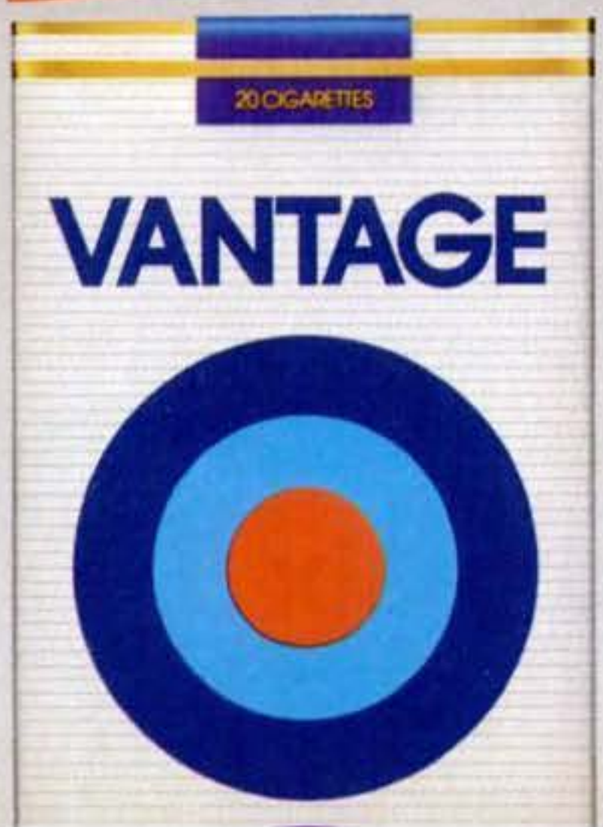

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The WHAT'S NEW magazine
Popular Science

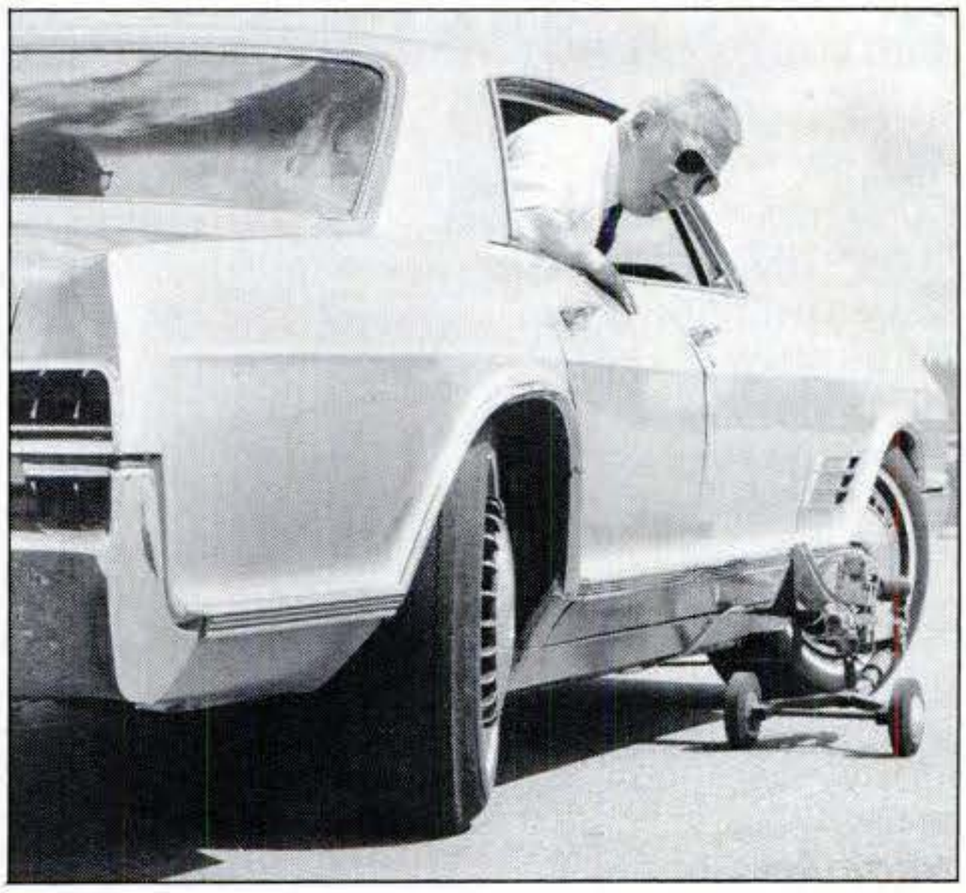
What's News

Four-wheel steering is the hottest automotive engineering development going because it improves handling and maneuverability at all speeds. Many of the world's auto makers are working on it, and we'll be seeing a flock of cars incorporating this engineering within the next few years.

But new it's not, I was surprised to learn. Look at that picture at the right again. The date on the photograph is July 10, 1968—almost 20 years ago. It shows a General Motors experimental car. The little outrigger wheels are used to measure lateral movement.

I asked Dan McCosh, POPULAR SCIENCE's new Detroit editor, to check on any additional work in the area he could find. He turned up the fact that Mickey Thompson ran a four-wheel-steering car in Indianapolis in 1967; there were several such cars built in the 1920s and '30s; one was built in 1915; and, says McCosh, "a French guy named Amedee Bollee built a steam-powered vehicle in 1876 that used the idea." So much for novelty.

But now it seems truly an idea whose time has come. Herb Shuldiner's piece in this issue gives all the details.



No more excuses

The proof is in: Seat belts save lives. A lot of them. New York, New Jersey, Michigan, and Illinois have had mandatory seat-belt laws in effect for varying periods of time. Not everybody wears the belts, of course, but monitoring shows that seat-belt use has increased. The result: While traffic fatalities in most of the country were up four percent over 1984, in those states with the new laws they plunged by as much as 28 percent. Safety experts estimate that more than 400 lives have been saved in those states in just a few months. Twelve other states have now approved seat-belt laws. They are California, Connecticut, Hawaii, Indiana, Louisiana, Massachusetts, Missouri, Nebraska, New Mexico, North Carolina, Oklahoma, and Texas.

Worried about ozone?

You should be. Back in 1974, three environmental scientists pointed out that Freon refrigerant gas and several other substances being released into the atmosphere in large quantities might have catastrophic long-term effects. These substances could gradually rise into the stratosphere, where they would destroy molecules of ozone floating there. If the process went far enough, it could, by destroying the ozone layer, let far more ultraviolet radiation from the sun reach Earth's surface. And that could enormously increase the incidence of malignant melanoma, a particularly deadly kind of skin cancer. The radiation could also damage production of some crops and the larvae of some marine organisms.

Now, a troubling report. Observations from a Nimbus-7 satellite have found a hole in the protective layer above Antarctica. At the same time, observations from the ground have shown a decline in the amount of ozone in the stratosphere.

Scientists don't know for sure whether the effect is being caused by Freon and other man-made contaminants or whether it's part of a long-term natural fluctuation. For example, some scientists hypothesize that the eruption of El Chichon in 1982 threw enormous quantities of sulfur particles into the stratosphere, causing the depletion.

But everyone agrees that the decline is real—and rapid. The unanswered question is, Will it reverse itself and build again, or is there real danger ahead?

Shuttle's computers belong in a museum

It's not that they weren't the best available when they were built. It's just that their age is showing. IBM started developing the then state-of-the-art computers in 1972, in time for a scheduled five years of testing before the first launch. So the most advanced spaceship in the world today has computers that represent the technology available when American troops were pulling out of Vietnam. That's why, despite the fact that there are six of them aboard the shuttle, computer failures keep happening.

So the shuttle is getting new computers. IBM, as before, is building them. The computers will be half the size and weight of the old ones, have 256 kilobytes of memory instead of 104, and are designed to run for 6,000 hours instead of 1,000 (IBM says they'll actually go 10,000 with ease). They will cost $500,000 against $1.5 million each for the old ones. And although work only started in January 1984, they already have been delivered and are undergoing three years of testing before making their first flight, scheduled for May 1987.

C. P. Gilmore
Editor-in-Chief

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PS EXCLUSIVE

4-WHEEL STEERING —here now for all-out performance

Experimental cars recently unveiled by many Japanese auto makers employ four-wheel-steering systems that radically improve handling and stability. For faster, more controlled turns and lane changes at high speeds, the rear wheels turn in the same direction as the front wheels. For tighter turns and low-speed agility, the rear wheels steer in the opposite direction of the front. Nissan now offers four-wheel steering in its flagship Skyline sedan in Japan. Mazda promises to offer the system in a production car in two years. And Honda, Mitsubishi, and Mercedes-Benz are all working on four-wheel-steering systems.

By HERBERT SHULDINER

MIYOSHI, JAPAN

Streaking down a 5,700-foot-long straightaway at Mazda's proving grounds here, I watched the speedometer of the prototype car I was driving hit 65 mph. Then I abruptly jerked the steering wheel to the left. The vehicle's rear end fishtailed, and I had to fight to control the car. "Now try it again," said Shigeki Furutani, an engineer sitting beside me, as he flicked a switch. I raced down the straightaway at 75 mph and again turned the wheel hard. This time the car remained perfectly stable and completely under control. I spent the next hour-and-a-half repeating such maneuvers. Each time Furutani flicked the switch one way, the car had a crisp, precise feeling of control. When he flicked the switch the other way, I had to struggle to keep the vehicle stable.

The switch, of course, changed the vehicle from two-wheel steering to four-wheel steering. The car is a test-bed for a production model Mazda will begin selling in two years, according to Takashi Kuroda, head of the company's research-and-development division. And Mazda isn't the only car maker experimenting with four-wheel steering. Honda, Mercedes-Benz, Mitsubishi, Nissan, and Toyota have all built four-wheel-steering cars. In fact, Nissan recently introduced a four-wheel steering option in its Skyline luxury sedan in Japan. Does four-wheel steering promise a revolution in car handling, as anti-lock braking does in stopping [PS, Nov. '85]? Or is it just another engineering fad that adds expense and complexity to cars?

The idea certainly isn't new: A Frenchman built a steam-powered four-wheel-steered prototype in 1876. Other efforts were made in 1915, and in the '20s and '30s. Mickey Thompson built an Indy car with four-wheel steering in 1967. Later, Thompson converted an Oldsmobile Toronado to four-wheel steering.

None of these efforts resulted in a practical system. Now many auto companies are racing ahead to perfect four-wheel steering and get it into production cars. Why is the Japanese auto industry on a crash program to perfect such systems for cars now? To find out I recently spent two weeks in Japan visiting car companies, interviewing engineers, and driving the four-wheel-steering cars they are working on.

Show cars

My first stop was the 26th International Tokyo Motor Show. I walked through a half-dozen buildings at the Harumi Fairground, viewing hundreds of cars—many of them revolving on turntables and surrounded by brightly-costumed models. There seemed to be a great deal of sameness about the show cars until I started looking under the skin. Then it suddenly struck me. An engineering revolution was taking place amid all the glitter and hype: four-wheel steering. A half-dozen cars—three from Nissan and one each from Mazda, Mitsubishi, and Toyota—had systems in which the rear wheels are designed to steer instead of merely trailing along.

The Mazda four-wheel-steering system in its MX-03 show car evolved from the company's earlier MX-02, which also had steerable rear wheels. "The rear wheels of the MX-03 have a maximum steering angle of six degrees," says Noritaka Yasuda, Mazda's manager of chassis testing and research. The steering angle of front wheels ranges between 30 and 40 degrees, depending on the model. According to Yasuda, the four-wheel-steering system in the MX-03 has an eight-bit computer that monitors vehicle speed and steering-wheel angle to determine when the rear wheels should turn—and how much. "When the car's speed is less than 25 mph, the rear wheels steer in the opposite direction of the front wheels," Yasuda says. He calls this the contra-phase mode (see drawing) and claims that it helps low-speed maneuverability.

"At 25 mph the rear wheels are in a neutral steering position [as in a conventional car], but as you increase speed the rear wheels start turning in the same direction as the front wheels," Yasuda says. He calls this the phase

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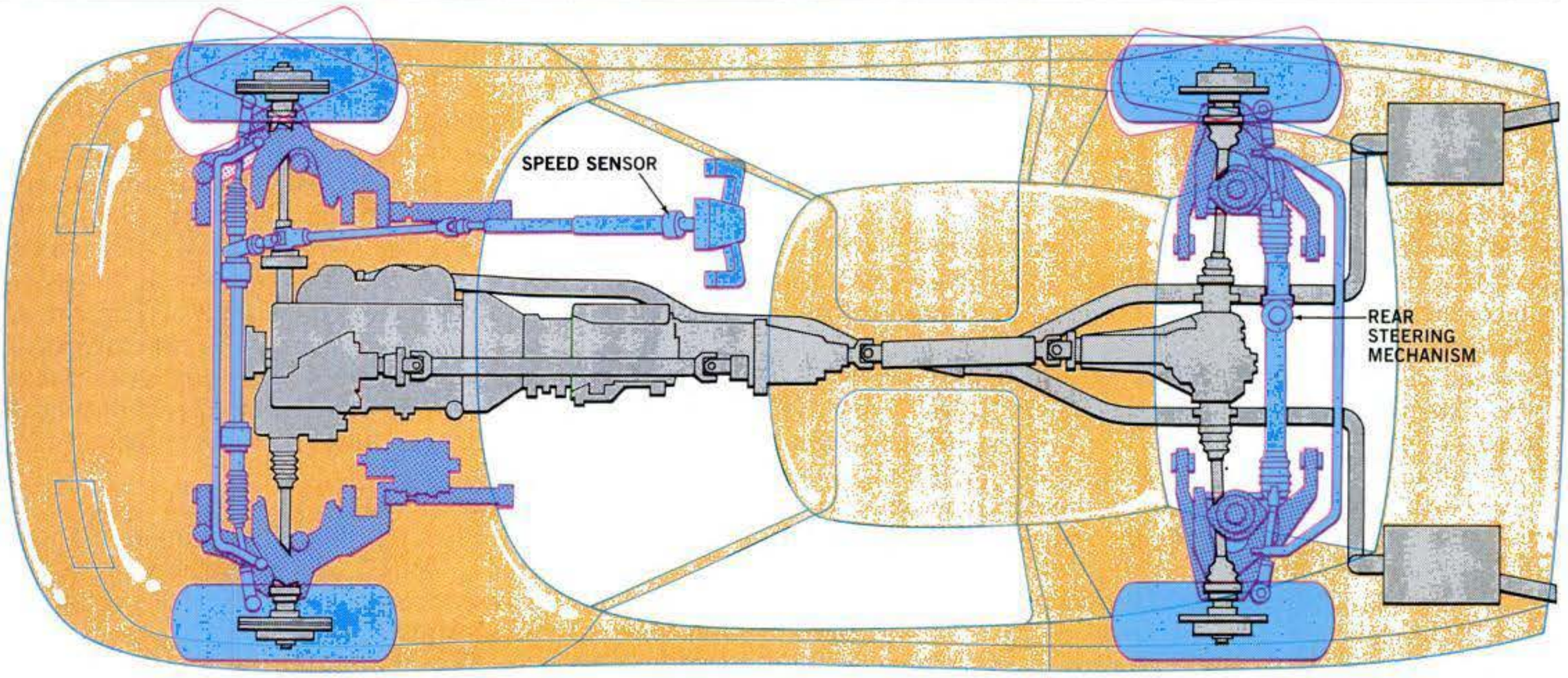

Mazda MX-03 has a four-wheel-steering system, shown with wheels in contra-phase. Drawing shows the location of mechanical and electronic components for the system, including a vehicle speed sensor and microprocessor.

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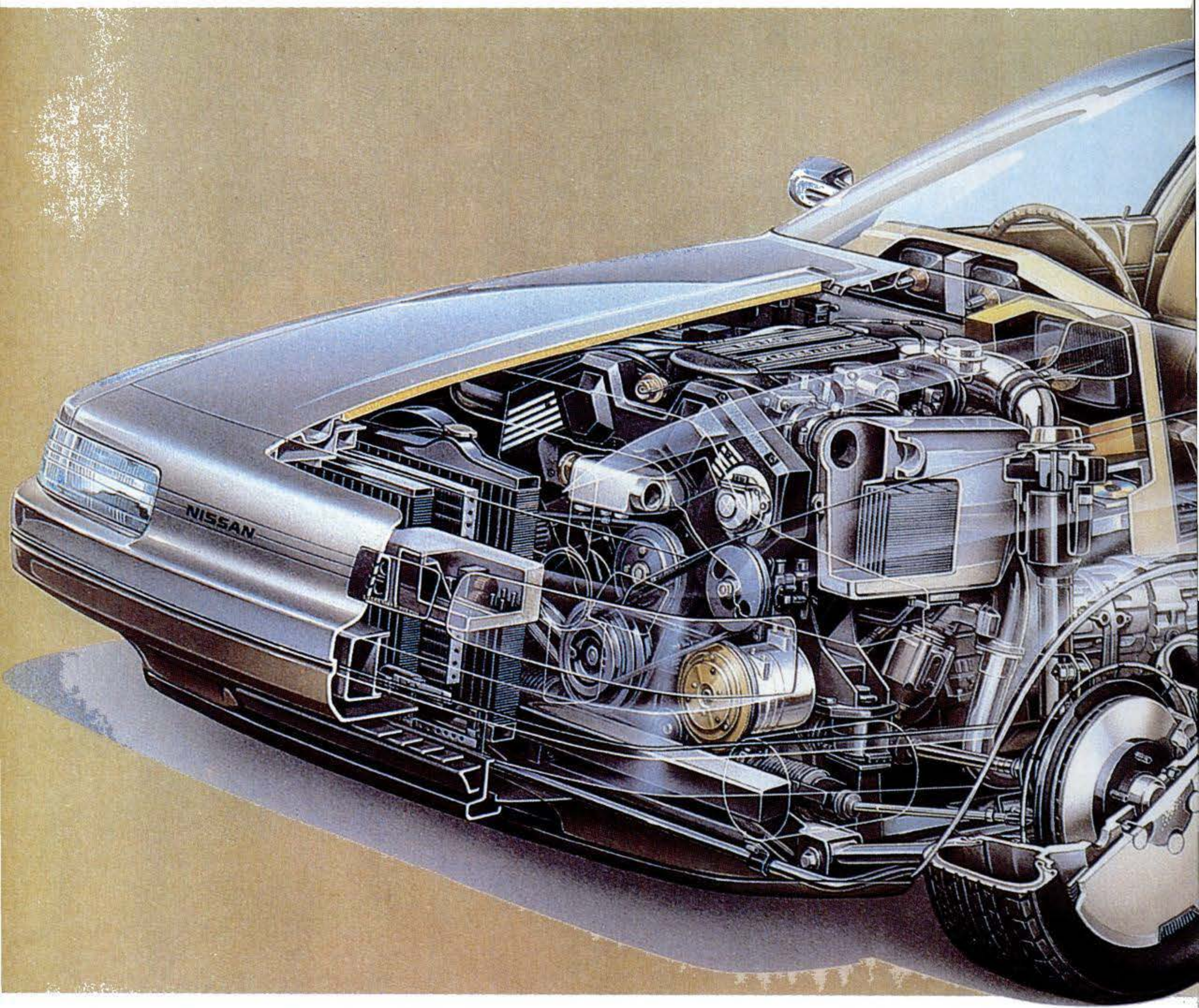

mode. "This increases the high-speed stability of the vehicle," Yasuda claims. The performance is improved on both wet and dry roads—and on gravel roads, Yasuda says. In Mazda tests, the four-wheel-steering car negotiated a slalom course about 10 percent faster than a car with two-wheel-steering.

(It's easy to see why four-wheel steering should, theoretically, produce this result. When a car goes around a curve, inertia tries to make it continue in a straight line. The force that keeps the car on the road is the friction between the tire and the road. With conventional front-wheel steering the rear tires tend to slide away from the direction of the front wheels when the car goes around a curve at high speed [see drawing]. Engineers have long believed that high-speed cornering could be accomplished with more stability by turning the rear wheels in the same direction as the front.)

"There's a fail-safe backup if the computer fails," Yasuda says. "The car monitors oil pressure in the rear power steering system. If there's a failure in the rear steering system, the backup disconnects it and the car reverts to conventional mechanical two-wheel steering."

"Zero slip cornering" according to Mitsubishi, is what results when you use the four-wheel steering system in that company's porpoise-like MP-90X concept car. Mitsubishi's four-wheel-steering system employs a computer that monitors engine rpm, vehicle speed, and the steering angle of the front wheels to control the rear wheels. The MP-90X's rear wheels—like those of the MX-03—steer in the opposite direction of the front wheels at low speeds and in the same direction at high speeds. The car also has a high-response steering system. The company claims that this gives the car crisp handling and allows a driver to use four-wheel steering's potential to the limit in avoiding obstacles or switching lanes at high speed.

More R&D is needed

Toyota's FXV also has four-wheel steering, but the system does not have a computer. The rear wheels are steered mechanically in response to the turning of the steering wheel, says Kiyoshi Matsumoto, a Toyota executive vice president. Matsumoto told me that the FXV's four-wheel-steering system is in a very early stage. "It will require further research and development before we see it fitted

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on our cars," Matsumoto says. The latest Toyota four-wheel-steering system has a maximum rear-wheel steering angle of 10 degrees. "We have not yet ascertained whether we need such a large steering angle," Matsumoto says. "We're talking about what can be done, not whether it's necessary." Matsumoto is also concerned about steering-wheel feel: "The four-wheel-steering we now have feels heavier than [steering systems in] conventional cars, and we have to determine how and to what extent we need to compensate for this with power steering." At the same time, Matsumoto is impressed with the FXV's handling performance. "It's a great boon when you want to negotiate a winding series of bends at high speed," he says. "You can do this about six mph faster with four-wheel-steering."

Honda has outfitted at least one Prelude with an experimental four-wheel-steering system. Company officials turned down my request for a test ride—or even an interview with engineers working on the project. But PS learned that the Honda system is relatively primitive, with no computer to control the amount of rear-wheel steering. The rear wheels respond via a mechanical linkage to the

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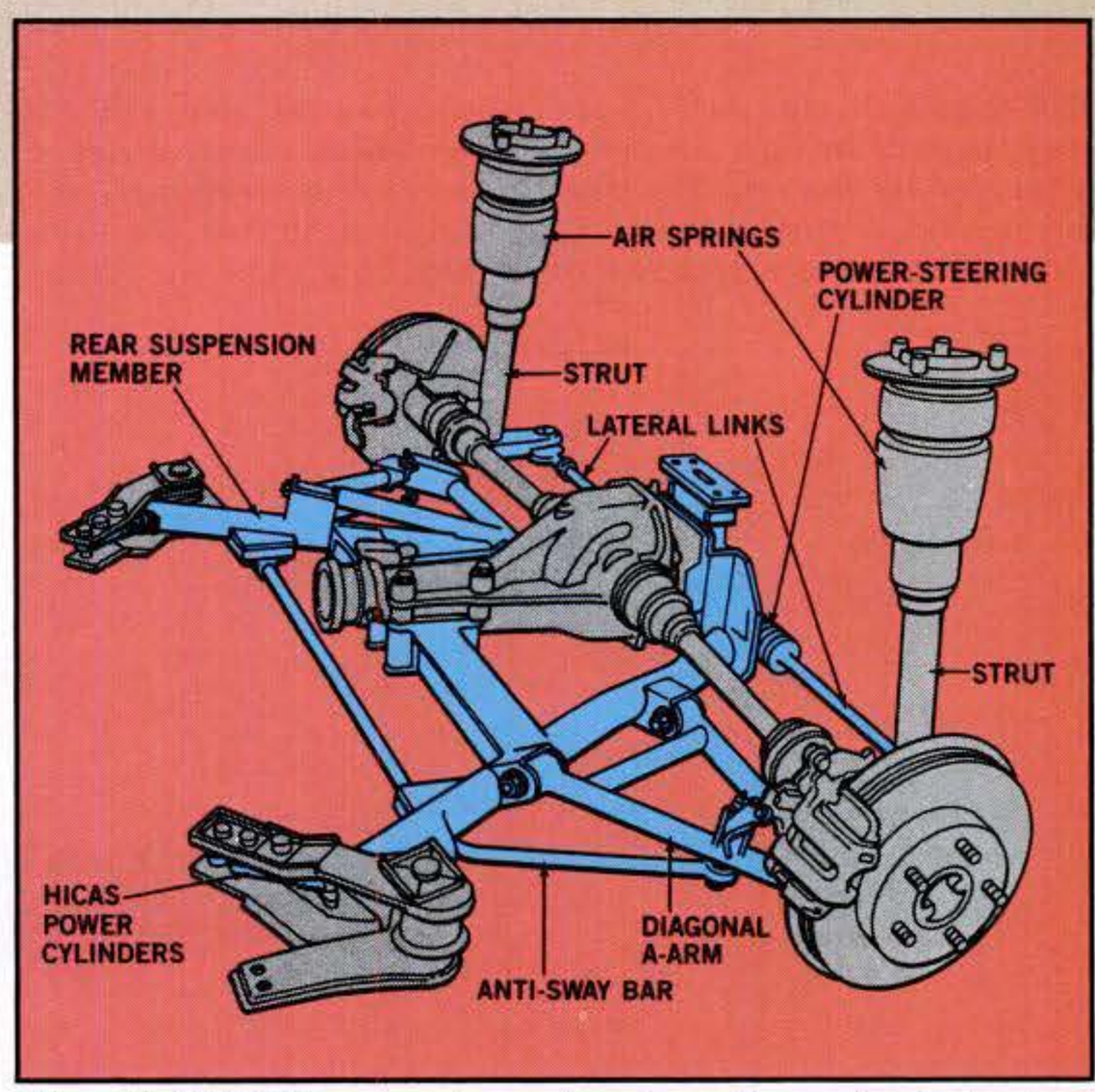

Nissan's CUE-X concept car is a true four-wheel-steering vehicle. It uses the HICAS suspension (drawing) for passive steering of rear wheels up to 0.5 degree. The CUE-X also has a separate active hydraulic steering system, which turns the back wheels up to seven degrees in the opposite direction of the front to improve low-speed maneuverability.

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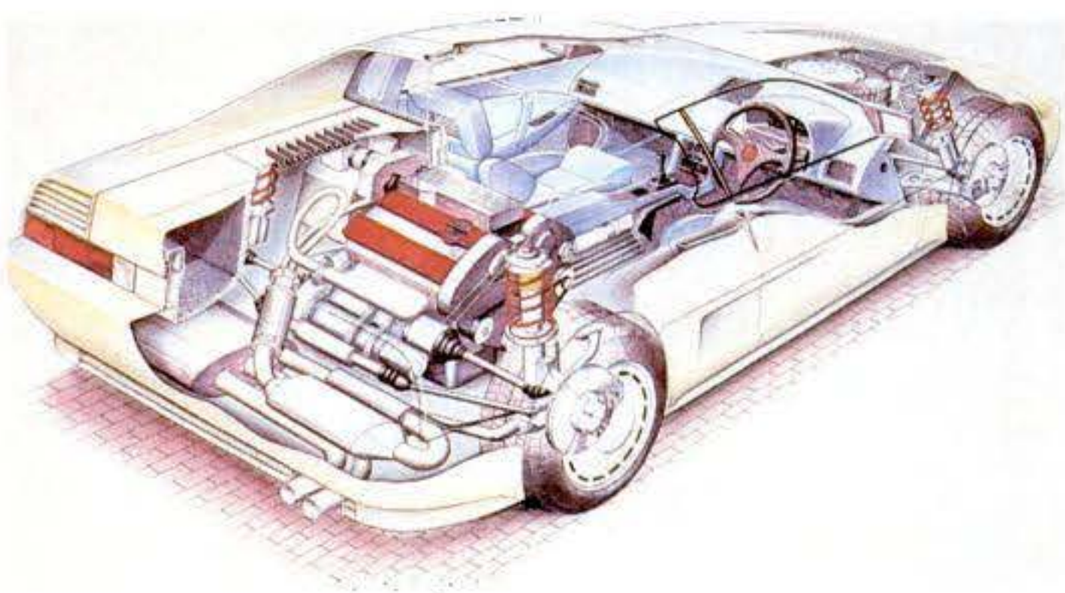
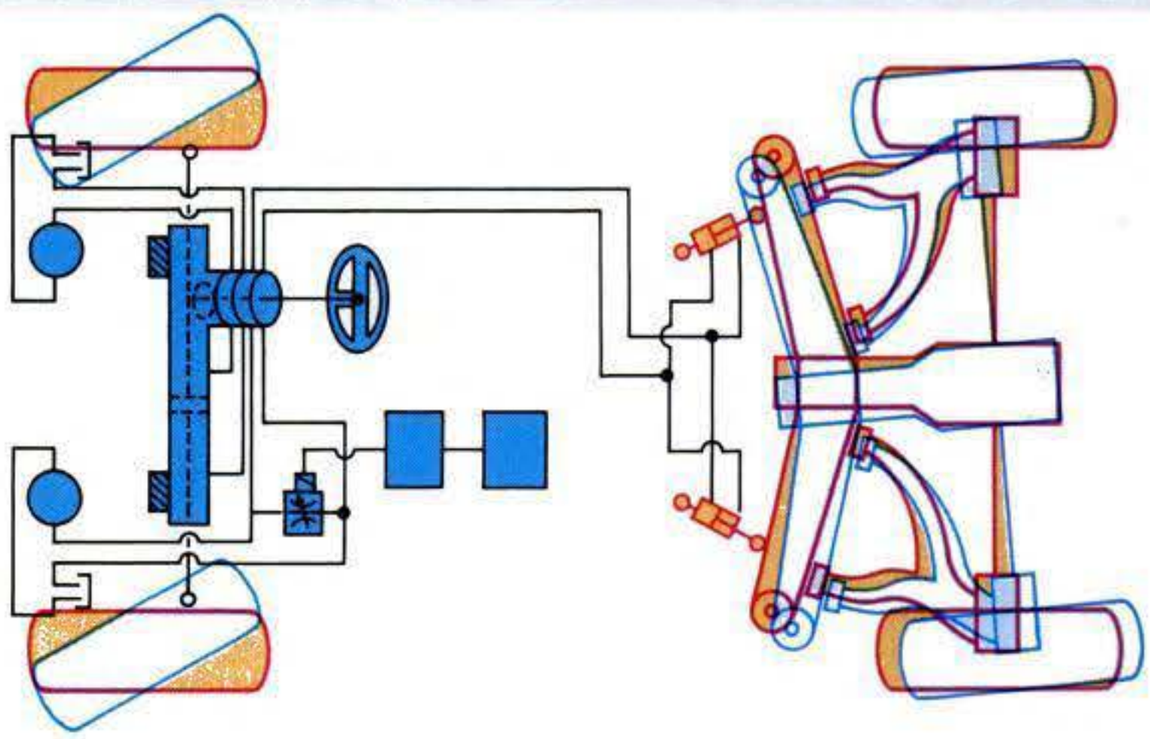
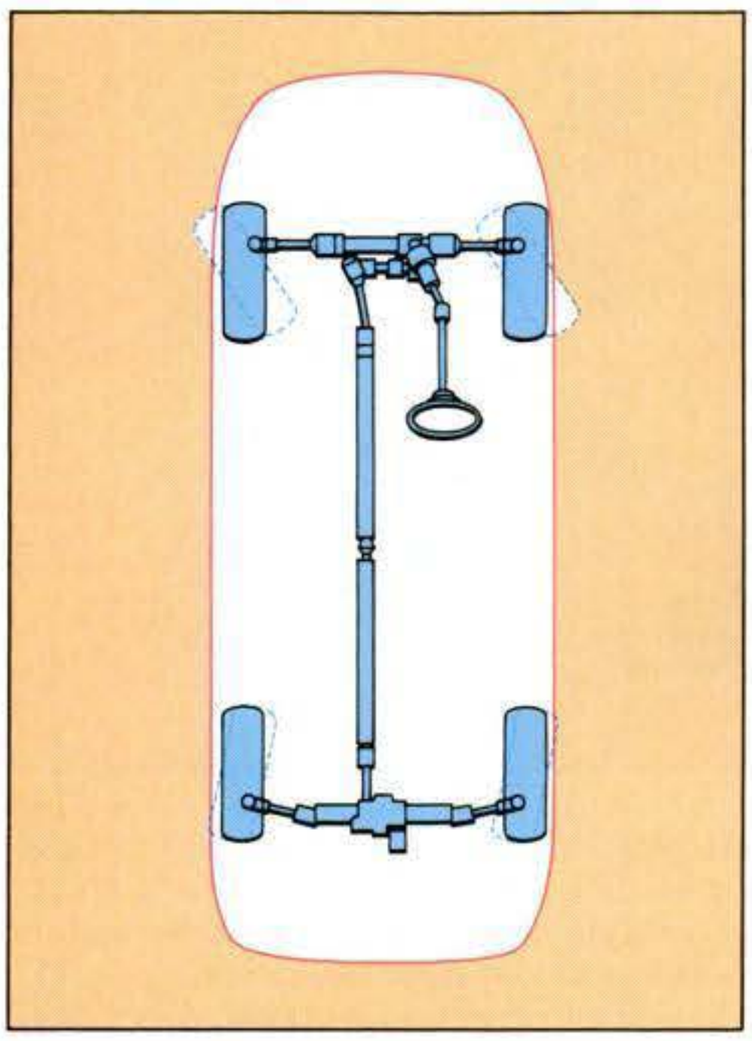




Mid-engine Nissan MID 4 sports car has the new HICAS rear suspension (see cutaway above), which allows the rear wheels to be steered. The back wheels are steered up to 0.5 degree by a spring-loaded hydraulic actuator through knuckle arms in a manner that's similar to the way front wheels are controlled by the steering wheel. Hydraulic pressure is supplied by the power steering pump, which is regulated by valves designed to respond to lateral acceleration and vehicle speed. Drawing on right shows the maximum steering angles for front and rear wheels.



Rear wheels steer in same direction as the front wheels for high-speed maneuvering. During low-speed maneuvers, the rear wheels turn in the opposite direction (see drawing).

Rear-wheel steering in Toyota's experimental FXV concept car is mechanical. The driver's turning of the steering wheel determines rear-wheel steering angle up to a maximum of 10 degrees.

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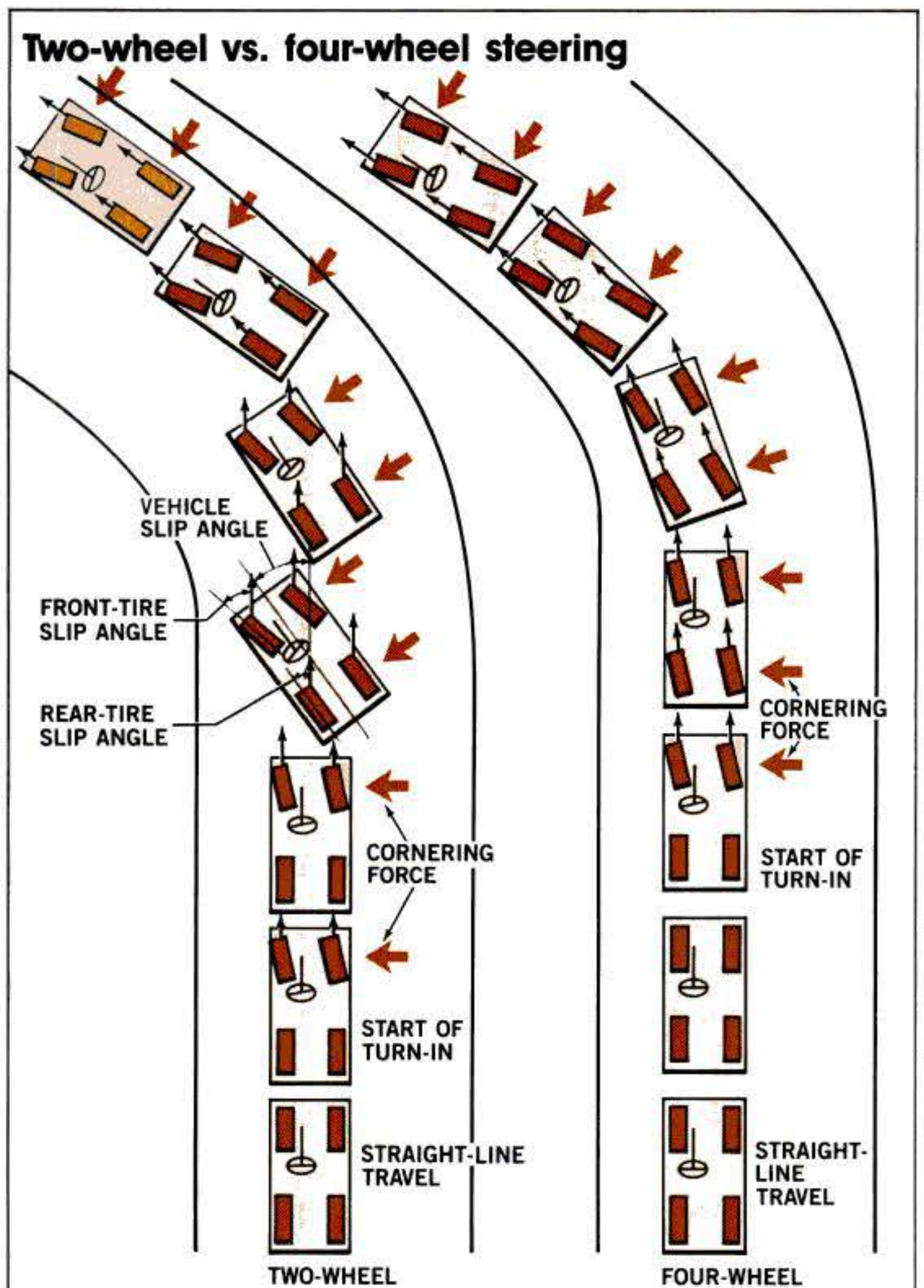
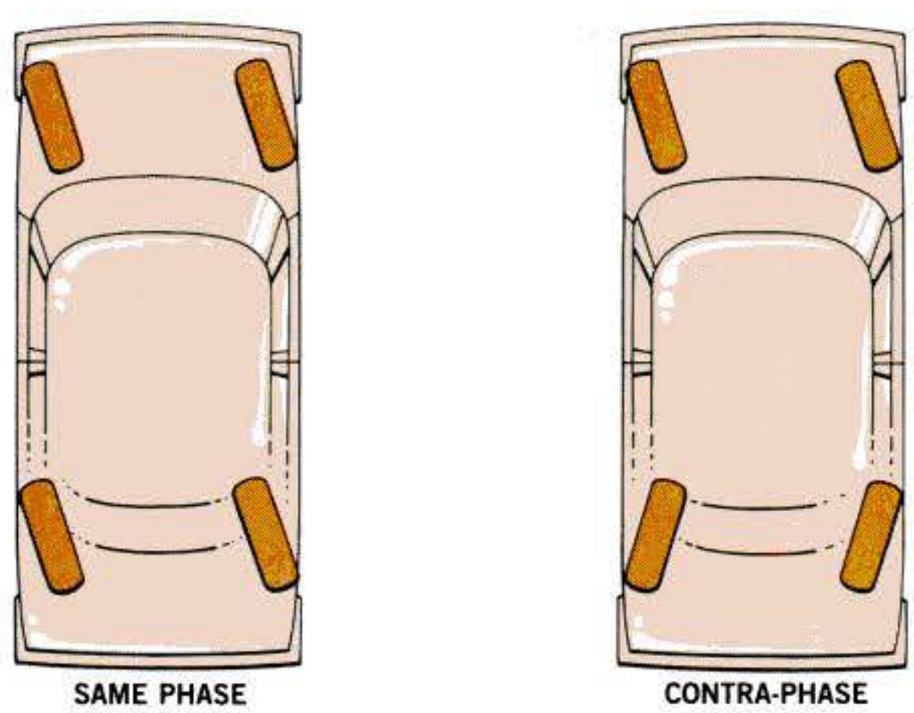


The contribution of four-wheel steering to smooth cornering is demonstrated in these drawings. Note how much more tightly the maneuver is accomplished in the four-wheel-steering car. With only front-wheel steering (drawing at left), the rear end of the car swings to the right and the nose swings to the left. With four-wheel steering, the vehicle tracks straighter and feels more controllable.



Active four-wheel-steering system allows the rear wheels to steer in the same direction as the front wheels (same phase) for speed stability. For low-speed maneuvers, the rear wheels steer in the opposite direction of the front (contra-phase).

front steering system. One Honda employee who has driven a car with the system told me that the experimental Prelude seemed faster in cornering than a conventional model. According to a company spokesman, Honda has no plans to incorporate the system in production cars in the foreseeable future.

Nissan, on the other hand, has an ambitious four-wheel-steering research-and-development program underway. The company's most advanced system is in its CUE-X, a high-performance concept sedan. The CUE-X has a high-capacity suspension (HICAS), which is also used in the company's MID 4 prototype sports car and the Skyline luxury sedan, already on sale in Japan. HICAS permits up to 0.5 degree of rear-wheel steering when a car is cornering at 19 mph or more.

HICAS is an analog system (no microprocessor is used) that responds to lateral acceleration and the car's speed to steer the back wheels. When more than 0.5 *g* lateral acceleration is reached on the Skyline's rear wheels, a spring-loaded hydraulic actuator steers them in the same direction as the front wheels. Nissan engineers told me that 0.5-degree rear-wheel steering was suitable for high-speed cornering in the current generation of cars, but that the rear-wheel steering angle may be increased on future cars "as drivers get used to it." In many respects HICAS more closely resembles the rear-wheel action of the Mazda RX-7 and Porsche 928. Actuators cause the rear wheels in the latter two cars to toe in and provide stability in high-speed turns. The HICAS in the MID 4 and the Skyline does not respond to commands from the steering wheel.

In addition to HICAS, the CUE-X also can steer its rear wheels up to seven degrees in the opposite direction of the front wheels to aid low-speed maneuverability—a feature not found on the other Nissan cars. The CUE-X system is controlled by an eight-bit computer, which also controls the car's pneumatic suspension and air spoilers.

At the test track

Shortly after my visit to the Tokyo Motor Show, I found out that four-wheel steering is more than a gimmick for a show car. At Nissan's Tochigi proving grounds I drove a production Skyline in both high- and low-speed driving conditions. The first thing that struck me was that steering-wheel feel is no different from that of two-wheel steering.

Nissan claims that HICAS gives the car the effect of driving with racing tires—when the vehicle is equipped with street tires. I can't verify that because I was unable to drive a Skyline without HICAS in a back-to-back comparison. The Skyline I drove does not handle as crisply as the best handling cars, but HICAS may make the car a better handler than it would be without the system.

Then I flew to Mazda's Miyoshi proving grounds to test its four-wheel-steering system, probably the most advanced in the industry. Instead of the MX-03 (shown on the cover) I was led to a rather shopworn 626. Chassis engineer Noritaka Yasuda apologized for the condition of the car when he saw the puzzled look on my face and explained that the 626 was a test-bed for the four-wheel steering in the MX-03. The 626 didn't even have a back seat: The rear-wheel steering suspension occupied the space.

But if the engineering vehicle looked rough, it was smooth once I got behind the wheel. With engineer Shigeki Furutani sitting beside me controlling the 626's use of two- or four-wheel steering, I put the vehicle through a series of high-speed lane-change simulations. There was no question in my mind that when four-wheel steering was used, the car was more controllable and handled more crisply.

[*Continued on page 115*]

Encyclopedia on a CD

"It's the same as an audio compact disc," says John Cole, vice president of business development for Grolier Electronic Publishing, as he holds up a silvery CD between his fingers. "But instead of music, it contains words —nine million of them."

Produced by Grolier (95 Madison Ave., New York, N.Y. 10016), the disc is the first compact-disc read-only memory (CD ROM) to go on sale. Like an audio disc, the 4.72-inch wafer stores digital codes that are read by a laser beam. But unlike an audio disc, wherein the codes represent sounds, these codes represent symbols—text characters and numbers—for display on a computer.

"The disc contains all 21 volumes of Grolier's *Academic American Encyclopedia*," says Cole. "I can find any part of it—from 'android' to 'zoology' —in less than five seconds." He placed the disc in a player, tapped a few keys on the keyboard in front of him, and in seconds the screen filled with text.

"You can find information in either a browse or word-matching mode," says Cole. In the browse mode, you find related topics by being shown all the names of articles that deal with the subject you request. "Type in RIGHT OF PRIVACY," he says, "and you see top-

Hot-rod computer modems trim your phone bill

I snapped the last cables in place, flicked on my computer, and punched a series of keys. Within seconds, the computer had dialed the phone to Newsnet, a national on-line newsletter data base, and was collecting the latest scoop on the electronics industry.

Big deal, right? You hear about this kind of computer-to-computer communication all the time. But hold on: Hooked between my computer and telephone line is a Hayes Smartmodem 2400, one of the new breed of 2,400-bit-per-second (bps) super-fast modems. (Baud, another modem-speed designation, applies to slower speeds, such as 300 bps.)

At 2,400 bps, messages from the distant Newsnet computer flashed on my screen at 240 characters per second. That's twice as fast as conventional 1,200-bps modems and eight times as fast as vintage 300-bps models ["Choosing the Right Modem," PS, Oct. '84]. At 2,400 bps, my calls are shorter and my phone bill is smaller.

What's the cost of supercharged performance? The Hayes Smartmodem costs $795, only $200 more than the average 1,200-bps model. Other 2,400-bps units, available from more than a dozen manufacturers, are priced about the same. But by autumn 1985, expect to see them priced at less than $600.

The new 2,400-bps modems use quadrature amplitude modulation: Two signals are sent down the phone line at the same time. They don't interfere with one another because they're timed a quarter of a cycle apart.

Because you won't always hook up to a computer with a 2,400-bps modem, most models also operate at 1,200 and 300 bps. To be able to talk to as many

Hayes Smartmodem 2400 (left) and U.S. Robotics Courier 2400 (above) handle 2,400 bps and slower data rates.

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ics ranging from legal aspects to abortion." In the word-matching mode, you ask to see articles that contain a specific word or words.

The incredibly quick retrieval time is due to a 155,000-word index contained on the disc. The computer first checks the index; the index tells the computer where on the disc to find the requested information. Future versions could be enhanced dramatically. "The disc can hold up to 100 million words," says Cole. "That additional space could be devoted to computer graphics and pictures."

Although the demonstrations were done on an Atari ST and IBM PC computer, nearly any brand will work, and says Cole, "the drives [players] will be available shortly from companies such as Denon, Hitachi, Panasonic, Philips, and Sony." Once you hurdle the price of a disc drive (estimates range from $300 to $1,000) and a computer, the $199 encyclopedia on a disc could rival its $450 paper cousin. "However," says Cole, "lots of people will still want to hold a book and flip through its pages. The disc really doesn't give you more because the words are the same." Then with a smile he adds, "Only now you can find them all."—*William J. Hawkins*

computers as possible, be sure the modem you buy operates at these rates.

The new 2,400-bps modems do more than talk fast. Many have additional advanced features, like auto-answer/dial, automatic error correction to retransmit garbled messages, and password protection.

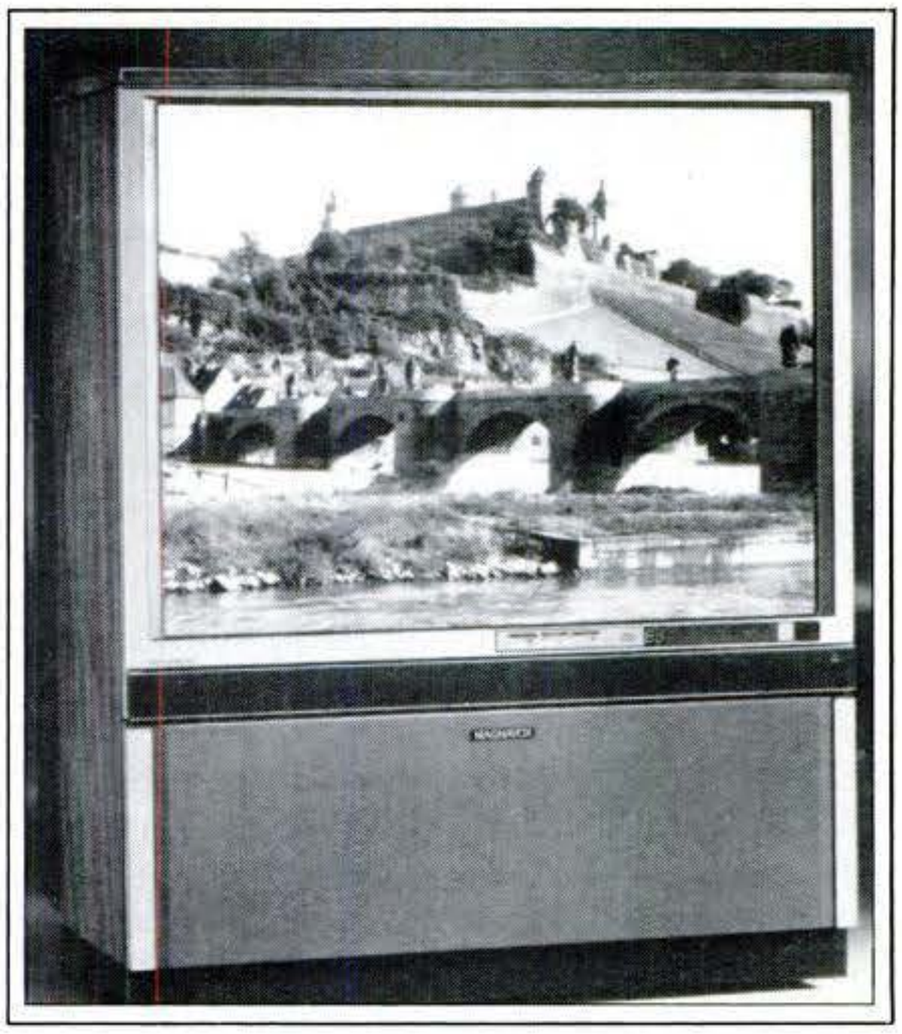
Other features include internal memory for a dozen or more frequently called numbers, adaptive dialing that senses whether to dial with pulses or tones, and linked dialing that automatically tries a second number.

Because 2,400-bps modems are new, don't expect friends, businesses, or all on-line information companies to offer the service.—*Gordon McComb*

MAKERS OF 2,400-BPS MODEMS

AT&T National Sales Center, Nashville TN 37027; **Case Rixon Communications,** 2120 Industrial Pkwy., Silver Spring MD 20904; **Cermatik Microelectronics,** 1398 Borregas Ave., Sunnyvale CA 94088; **Codex,** 20 Cabot Blvd., Mansfield MA 02048; **Concord Data Systems,** 3030 Bear Hill Rd., Waltham MA 02154; **CTS Corp.,** Datacomm Prod. Div., 6900 Sandy Oak Rd., Eden Prairie MN 55344; **Datec,** 200 Eastown Dr., Chapel Hill NC 27514; **Gandalf Technologies,** 109 S. Noel Ave., Wheeling IL 60090; **Hayes Microcomputer Prod.,** 5923 Peachtree Industrial Blvd., Norcross GA 30092; **Microcom,** 1400A Providence Hwy., Norwood MA 02062; **MultiTech Systems,** 82 Second Ave. S.E., New Brighton MN 55112; **Novation,** 20409 Prairie St., Chatsworth CA 91311; **Penril DataComm,** 207 Perry Pkwy., Gaithersburg MD 20877; **Racal-Vadic,** 1525 McCarthy Blvd., Milpitas CA 95035; **Universal Data Systems,** 5000 Bradford Dr., Huntsville AL 35805; **U.S. Robotics,** 1123 W. Washington Blvd., Chicago IL 60607; **Ven-tel,** 2342 Walsh Ave., Santa Clara CA 95051

Ultra-wide-angle projection TV

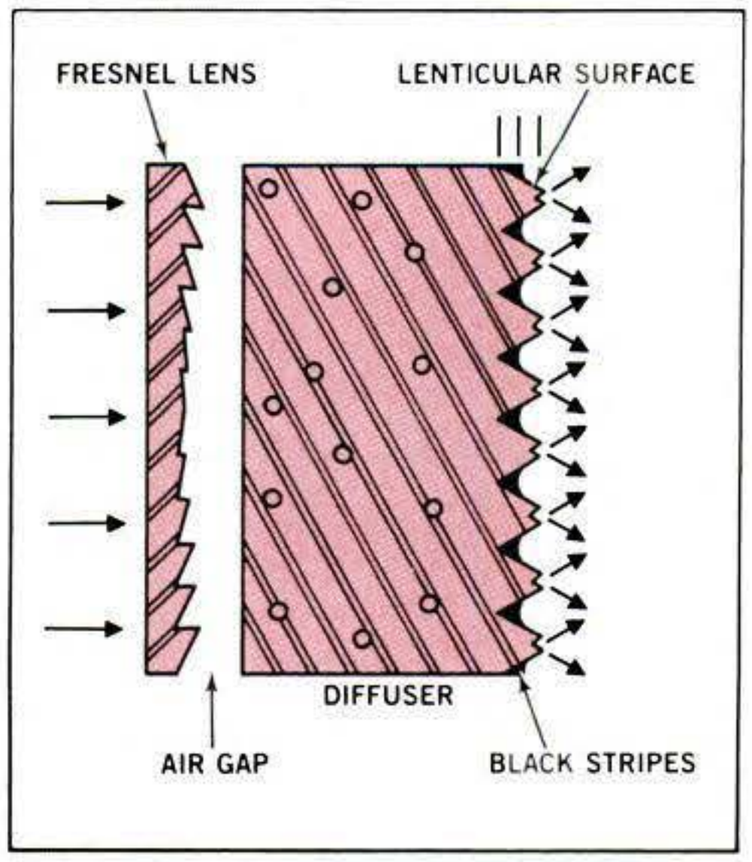


A 37-inch Magnavox projection television in the demonstration room seemed like others now in stores. With its slim space-saving cabinet, the rear-projection set looked like an ordinary color TV set with a supersize cathode-ray tube.

"Watch this," said one of the engineers showing the set. "You can't do this with other receivers." He flicked the TV on with a remote control, then slowly turned the set until the bright, sharp picture was at right angles to me. Remarkably, the picture brightness didn't fall off as the set pivoted. Five Magnavox 37-inch sets now feature this ultra-wide-angle viewing capability, with one model offering superior resolution for optional computer inputs or other video sources with exceptional detail.

Poor off-axis brightness has been a major shortcoming of two-piece and rear-projection sets for many years. With some early low-brightness models, standing only 15 degrees or so off the projection screen's center axis sharply reduces picture brightness. The dimming narrows comfortable viewing angles in a room and limits how many persons can watch the TV at one time.

Most rear-projection sets use red, green, and blue projection tubes; lenses; and large mirrors to project TV images onto the rear of a two-piece plastic screen. The separate colored images merge to form a full-color picture. A rear section of the screen is a giant Fresnel lens (see drawing below). The lens gathers light from the projection tubes and, together with a diffusing element, beams it toward you. The diffuser spreads the light vertically. A second part of the screen, the grooved lenticular array, distributes light horizontally into the room. Usually (*not* as shown below), the lenticular array is on the inside surface of the front section. In addition, closely spaced narrow black stripes on the screen's outside surface absorb ambient room light and improve picture contrast.



Wide-angle light beams

Designers for Magnavox used a computer program to create a new type of lenticular array. Instead of the limited horizontal spread of ordinary arrays, the new design beams light outward for a 180-degree viewing angle. Inside each lenticular element, light is reflected away from the black stripes into a tip whose shape refracts it outward at wide angles (see drawing). The technique, according to Magnavox engineers, also minimizes the shifts in color that occur when you watch ordinary large-format TV screens at off-center angles.

Prices for the 37-inch TVs range from $2,400 to $2,900, with the model 8CM700 (photo) also offering 700-by-240-line resolution and a variety of input jacks as a color computer monitor.—*John Free*

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The pick of Paris

The Paris Air Show, that is. Every two years, airplane makers from the world over bring their newest and wildest craft to the City of Light. This year POPULAR SCIENCE picks a portfolio of the best of the show—from the world's largest plane to a flying car.

By BEN KOCIVAR
Photos by the author

LE BOURGET, FRANCE

If you're an aviation buff, the biennial Paris Air Show is your Mecca.

It's a two-week all-you-can-absorb-about-the-newest-planes fest held every other summer at Le Bourget, Paris's second-largest airport. The setting is appropriate: Not only does the airport house an important aviation museum, but Charles Lindbergh set his plane down here on May 21, 1927, 33½ hours after leaving New York.

The Paris Air Show is where you see the high-tech fliers of the future—side by side with some wacky-looking craft. This year's crop featured 230 planes and helicopters from 33 countries—everything from Soviet cargo haulers to French ultralights—representing the work of aviation's big guns like Dornier and Lockheed as well as that of lone-wolf designers.

There's more. Scattered through a dozen pavilions were 1,100 indoor exhibitions, including scores of models of advanced-concept space shuttles and next-generation fighters. The crowds—the airport is a short bus ride from the center of Paris—are a show in themselves: An estimated 500,000 people saw this year's show.

The last time I visited the show I came away shaking my head in wonder at the evolving know-how of airplane designers. This year was no different, although I was particularly wide-eyed at the technological advances made in structure and concept. Here are a few of the things that I saw.

There certainly were plenty of planes to gape at for the engineering and conceptual problems they overcame, but one stole the show: the giant Soviet An-124 (see photo), making its first Western appearance. Called the Rusland, although NATO refers to it as the Condor, this heavy-lift transport is larger and heavier than the Lockheed C-5A—now the world's second-largest plane. But size wasn't the only notable feature. Most observers walked away praising the nonstructural use of 12,000 pounds of composites in a production airplane, the fly-by-wire control systems (to save weight and improve reliability), and the smooth finish—a novelty on a nonmilitary Soviet aircraft.

From the world's largest plane, it was only a short walk across the field to the other end of the aeronautic spectrum: this year's group of ultralights. Many of these are still flimsy-looking tube-and-fabric fliers that depend on two-stroke engines and primitive weight shifting—the pilot leans one way or another—for maneuvering. But ultralights have begun to join the ranks of sophisticated fliers.

The new ultralights look like scaled-down versions of the popular flying machines of the early 1930s and post-World War II era (see photo). Many now feature such amenities as enclosed cockpits and airfoils and covered fuselages. Almost all sport a primitive windscreen—a concession to the chilling wind blasts encountered when cruising at 60 mph. And some ultralights have been outfitted with certificated four-stroke engines.

To keep this new breed of ultralight under 250 pounds—the class limit—designers have turned to composites. Some of the ultralights I examined at the show use a variety of plastics and epoxies in light structural reinforcement, streamlined fairings (the wing-fuselage connection), and wing coverings.

The days of weight shifting are drawing to a close. The first nail in the coffin was driven a couple of years ago when ultralights equipped with elevators and rudders—giving two-axis control—were tried out. This year, I was part of an enthusiastic crowd that looked on while three-axis-control (an aileron is the third element) ultralights were demonstrated.

Finally, there was one technological gain exhibited that you might never see—unless you're part of a flight crew or rate a seat on one of the new exotic executive planes. It's called the TV cockpit. Gone are conventional electromechanical circular dials. Their replacement? Electronic flight-instrument displays presented on computer monitors that supply an easy-to-read, precise record of the aircraft's performance, direction, and weather conditions. PS

More aircraft appear on following pages

It may have started out as an intercontinental-range executive jet, but the wide-body Canadair Challenger 601 (1) is being produced with winglets and General Electric CF-34-1A high-bypass-ratio turbofan engines. Its proposed uses: airline commuter, express-cargo carrier, maritime-surveillance craft, or air ambulance for any company that can meet the $15 million asking price. (Other business-jet manufacturers, such as Learjet and Cessna, are also extending their markets this way.) Challenger cruises at about 500 mph, has a range of more than 3,400 nautical miles, and can reach an altitude of more than 40,000 ft. The world's heaviest helicopter, the Soviet Mi-26 (2) is also the first chopper to successfully operate with an eight-bladed rotor. The rotor has a diameter of 105 ft. The 22-ton monster helicopter, powered by two 11,400-hp Lotarev free-turbine engines, can hit 183 mph and has a 500-mile range. But what's really impressive is that the helicopter can lift a payload that's equal to its own weight. The Mi-26 is designed to support construction and oil-exploration projects in remote areas of Siberia as well as to perform heavy-lift military operations. You can assemble the French single-seater amphibian, L'Hydroplum II (3), from a kit of preformed fiberglass parts. Powered by either a two- or four-cycle engine, the craft cruises at about 55 mph and has a range of 100 miles.

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PHOTO: CANADAIR

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Helicopter simulator from Italy (4) gives a memorable training ride to novices seeking rotary-wing experience. The capsule sits about 7 ft. off the ground and can rock and roll in nine directions to simulate zooms, dives, and turns—even inclement wind and weather. It can also elevate a fraction of an inch on a cushion of air and scoot 30 ft. across a flat surface. Three can sit abreast in the cockpit of the new-concept Performance 2000 (5), designed for French flying clubs. The trainer/personal plane, powered by a 108-hp Lycoming engine mounted high on the tail, features a high-efficiency ducted prop. The composite craft can cruise at about 125 mph and has a 500-mile range. Is it a plane? A car? It's a little of both. This fiberglass mock-up of a flying-car concept (6) was designed by J. G. Ebner, an engineer with Pilatus, the respected Swiss aircraft maker. The engines of the tandem two-seater are set in ducted-fan channel wings. Counterrotating propellers have unusual two-part blades that allow the pitch to be controlled by varying the angle of the flaplike trailing blade. Ebner hopes to have his machine flying—and on the road—in a year. Here's an up-to-date ultralight that recalls 1930s design: The all-composite Crosses-Airplume from Mavic (7) is a two-passenger plane with a three-axis control system; the craft is reportedly spin-proof. Cruising speed: 95 mph.

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The huge Soviet Rusland (8) is 228 ft. long with a 240-ft. wingspan (vs. 247 and 222 ft., respectively, for the Lockheed C-5A) and weighs a hefty 450 tons fully loaded at takeoff. The plane can carry a 330,000-lb. payload (slightly more than that of the C-5A) 2,429 nautical miles and has an empty-ferry range of more than 8,907 nautical miles. The hinged nose lifts up, and clamshell rear-cargo doors (not shown) allow straight-through loading of large vehicles. You couldn't find a better test of a pilot's mettle than a ride in this open-air tandem-seat ultralight (9) designed especially for flight schools. It's appropriate name: La Moto du Ciel, or sky cycle. The craft has conventional three-axis controls, a four-stroke engine, a tubular-metal fuselage, and a fabric-covered wing. Cruising speed: 80 mph. The bare-bones plane holds enough fuel to fly 6 to 10 hrs. Does a skeletal craft make you nervous? Then step up to a sophisticated ultralight: the J-3 Kitten (10). This scaled-down single-seat version of the extremely popular Piper J-3 Cub cruises at 55 mph. Dornier's newest amphibian airliner, the Seastar (11), features twin-turboprop engines mounted back to back. The prototype was destroyed recently when its landing gear malfunctioned. A similar-looking 12-passenger version (the only alteration introduced is a cantilevered fiberglass wing to eliminate drag) should be certificated in 1987.

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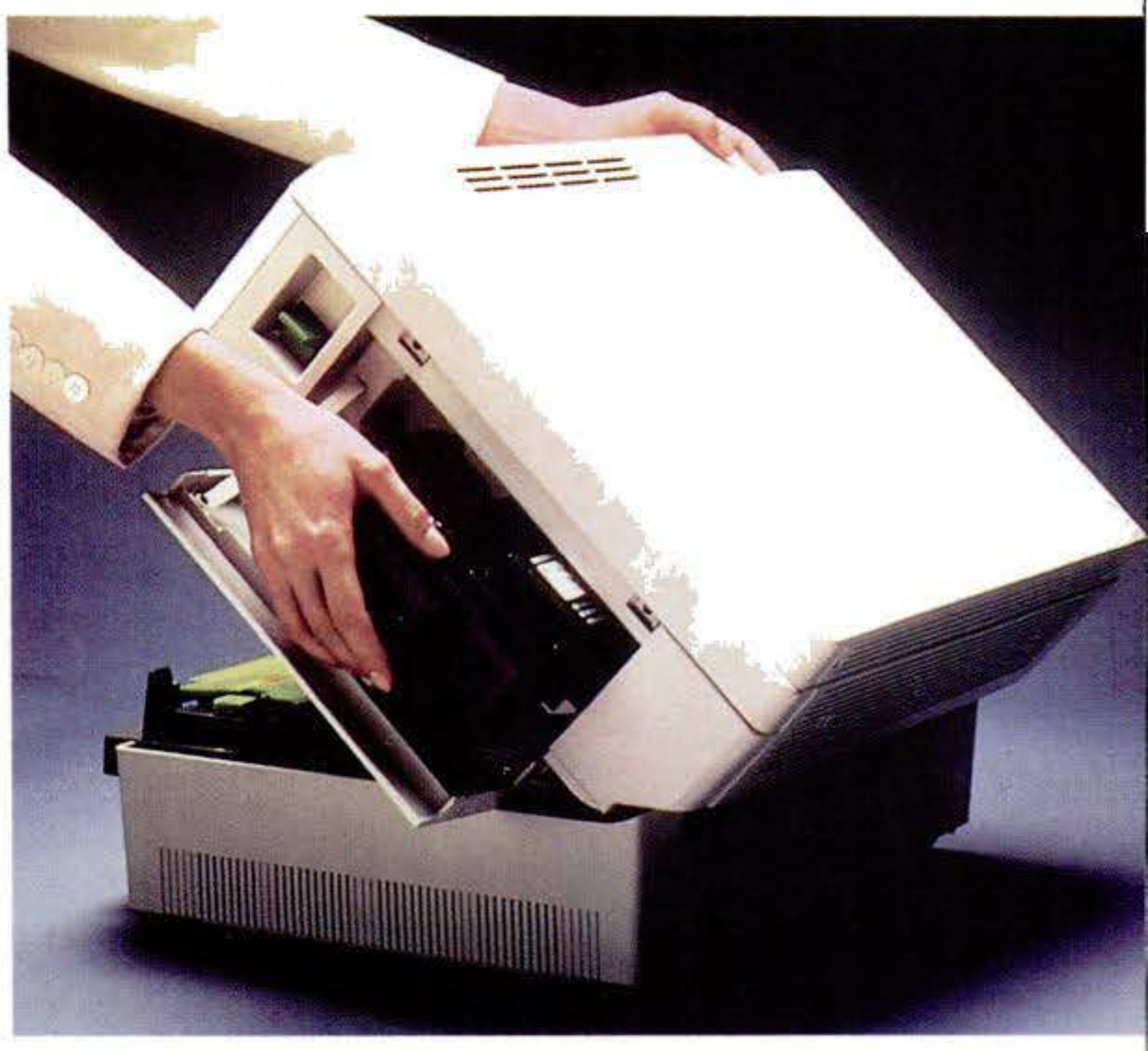
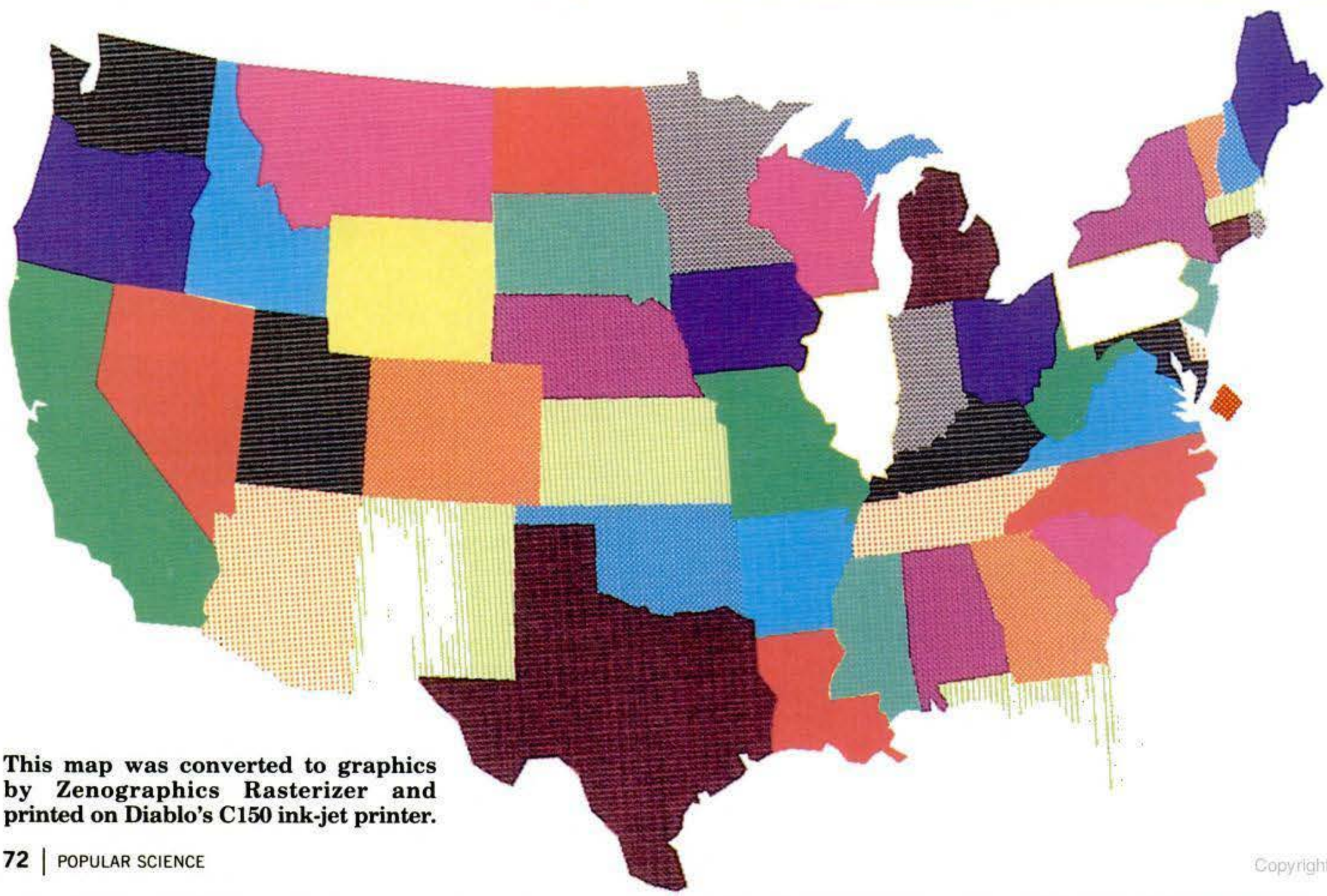
The rush to hush



Okidata's Okimate 20 thermal-transfer printer (above) creates seven main colors and dozens of others with dithering, as in the elaborate island scene shown (top right).



This map was converted to graphics by Zenographics Rasterizer and printed on Diablo's C150 ink-jet printer.

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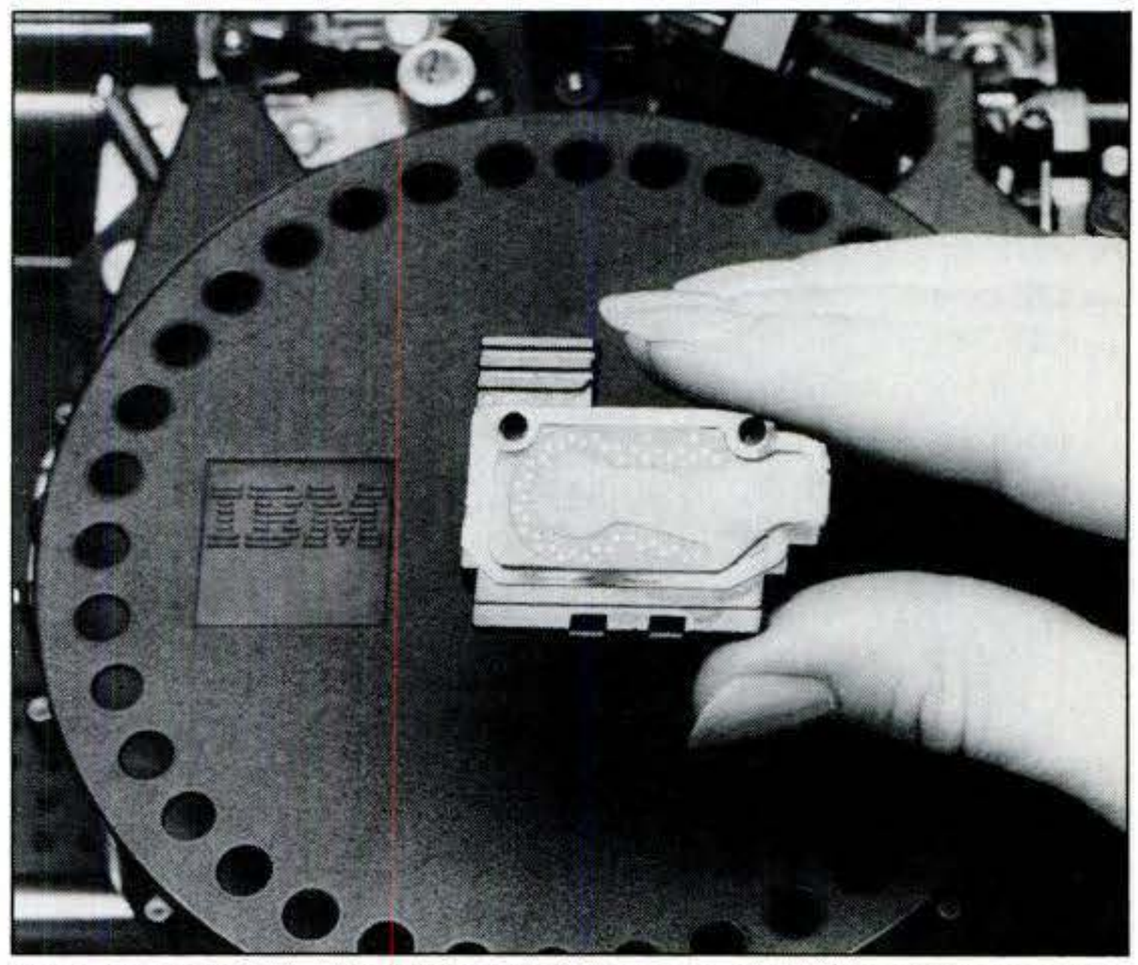
computer printers

Clicks, clunks, and the endless rat-a-tat-tat: They're all annoyances of typical high-quality computer printers. But no more. Non-impact thermal, ink-jet, and laser printers are now designed for speed, letter-quality printing, color graphics, and perhaps best of all, peaceful coexistence.

Laser-jet printing is done in black and white or in a single color using colored toner. The lion was created by the Hewlett-Packard LaserJet Plus (opposite page, right).



The print head on IBM's Quietwriter contains 40 tiny electrodes. To put print on paper, one or more electrodes emit a spark that heats and melts a spot of ink on the ribbon.

By GORDON McCOMB

John Cook tapped a few keys on his IBM Personal Computer, flicked on his printer, and sat back with a wide, satisfied grin on his face. "I couldn't stand the noise of my old dot-matrix model," my friend explained, "so I got one that's mute."

Instead of the familiar "rat-a-tat-tat," Cook's printer, an Okidata Okimate 20, whisked noiselessly as it created line after line of text. "There's no metal or plastic hitting the paper," Cook continued. "So there's hardly any noise." I stared at the page. The print was created with a silent thermal process (described below), and it looked almost as if it had been typed with a typewriter.

The Okimate 20 is just one of a new generation of non-impact printers. Unlike conventional impact printers, which pound out characters with solenoid-driven hammers or micro-sized needles, these models print by spraying ink, shooting a beam of laser light, or applying heat—like a branding iron—to a piece of paper.

Intrigued by the Okimate 20, I investigated non-impact printers more closely. What I found surprised me. I discovered that non-impact printers have been on the scene for a long time—in some cases, for several decades. But only recently have they been priced so that you and I can afford them.

I also discovered that the popularity of non-impact printers is growing phenomenally. Just about every printer manufacturer has at least one model, and many more are expected. But that's a problem. With new non-impact printers coming—and adding to the hundreds of printers already available—picking the right model can be difficult. Here are some buying tips.

Why non-impact printers?

Besides noise-free operation, non-impact printers have a few other important pluses over conventional impact printers:

Longer life. Because nothing strikes the paper, non-impact printers have fewer moving parts, so there's less to break down. For instance, the average print head of an impact dot-matrix printer wears out after printing about 100 to 200 million characters. The print head of a typical ink-jet printer can last about 10 *billion* characters.

Higher-quality printing. Impact dot-matrix printers create text and graphics by using tiny metal needles that strike the ribbon and paper. "There's a limit to how thin these needles can be—about eight mils with current manufacturing capabilities," says Roger Archibald, product marketing manager for Hewlett-Packard's LaserJet Plus printer. The majority of impact dot-matrix printers have large wires—14 to 20 mils thick—so you'll always see the dots that make up the print. Also, the number of wires usually determines the resolution (quality) of the print. Says Archibald: "There's a limit to how many needles can be stacked inside the print head. Right now that maximum is about 24."

Though non-impact printers, too, create text and graphics from individual splotches of ink, each dot is often

Continued

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Since OKIMATE works with word processor programs, changes and corrections can be made on the computer screen instead of paper. **Bold print.** Fine print. **Wide P**

When you mean business; move up to Letter Quality and the dots will literally disappear. Switch to COMPRESSED when you are short on space; or EXPANDE

Summary of Accounting Policies

Basis of Presentation

The accompanying consolidated financial statements include the accounts of Apple Computer, Inc. and all of its subsidiaries after elimination of intercompany accounts and transactions.

High-quality printing is obtained from all three printer types. Top left: Okidata thermal printing; bottom left: Epson ink-jet printing; above: print from Apple's LaserWriter.

less than four mils. And these printers have more dot-producing elements (up to 40) placed within the print head. Says Archibald, "The individual dots are hard to see with the naked eye, so text and graphics look clear and sharp."

Full-color printing. Some ink-jet and thermal-transfer printers can create full color on paper or clear overhead transparency film. The colors are deeper and richer than those from a dot-matrix unit.

While these are all good points to consider, non-impact printers have their disappointments, too. Foremost is that they print only one copy at a time; you can't use carbon paper. And, generally, non-impact printers are expensive. Although there are exceptions, such as the $268 Okimate 20 (see table), many high-speed high-quality printers fall in the $1,000 or more range. But the price you pay depends on the type of printer you need. And each type—thermal, ink-jet, and laser—has advantages and disadvantages.

Thermal

Thermal printers were once the misfits of the computer industry. Though inexpensive, they printed directly on special heat-sensitive silver-coated paper, which made them embarrassingly costly to operate. The coarse paper was also unsuitable for all business applications, and the print didn't last long—it gradually faded.

Direct thermal printers are still around, but their numbers are shrinking now that thermal-*transfer* printers—a surprisingly simple twist on an old idea—have become available. The difference? They print on plain paper.

Thermal-transfer printers work much like their direct-thermal ancestors in that they create text and graphics by heating elements in a ceramic print head. The difference is that they use a heat-sensitive ink ribbon rather than heat-sensitive paper. Individual points on the ceramic plate heat the waxy ink, melting it from the ribbon onto the paper.

The majority of thermal-transfer printers have nine heat-producing elements in their print heads, though some, like the Canon F-60, have up to 26. The more elements in the head, usually, the better the resolution, and the quicker a page of graphics can be printed.

"Each character or picture created with a thermal-transfer printer is composed of dots," says Ray Ewin, Okidata's supervisor of applications development for non-impact printers, "but the dots are small and spaced closely together. Print quality with even the least expensive units is high." He's right: The resolution of the thermal-transfer units can be as high as 350 dots per inch. In comparison, the average dot-matrix printer has a maximum resolution of 80 dots per inch—the better ones up to 144 dots per inch.

About a third of all thermal-transfer printers can print in color. Color printing is accomplished by using a ribbon composed of three colors—yellow, cyan, and magenta—strung one after another along its length. "The three colors can be mixed together to create up to seven full-density colors," Ewin says. "To mix colors, the printer raps out a line of text or graphics in one color, then goes over the same line with another color." With a process called dithering—adding dots of different colors closely together—thermal-transfer printers can create well over 30 colors.

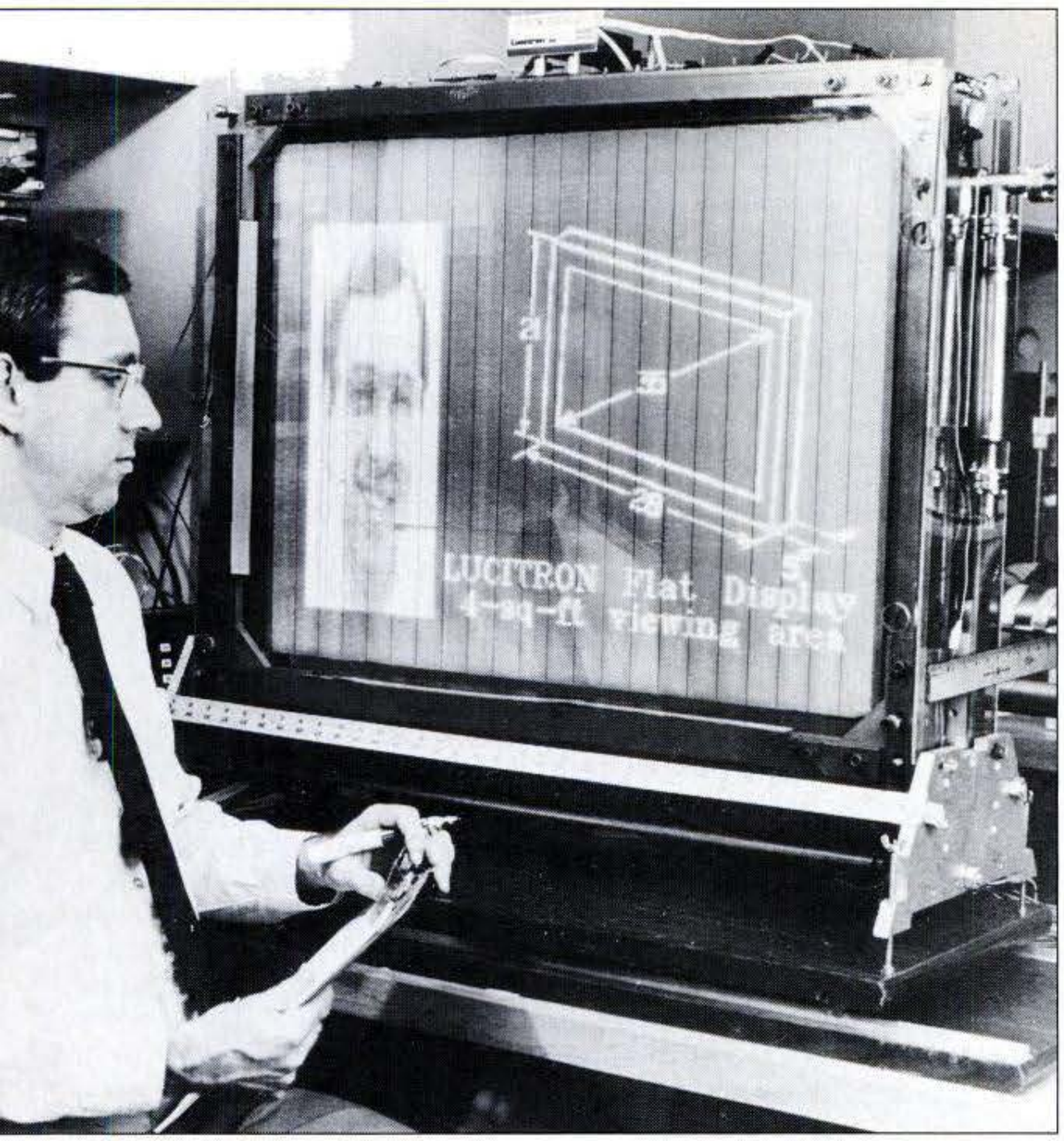
Although thermal-transfer color printing looks nice (the colors are al-

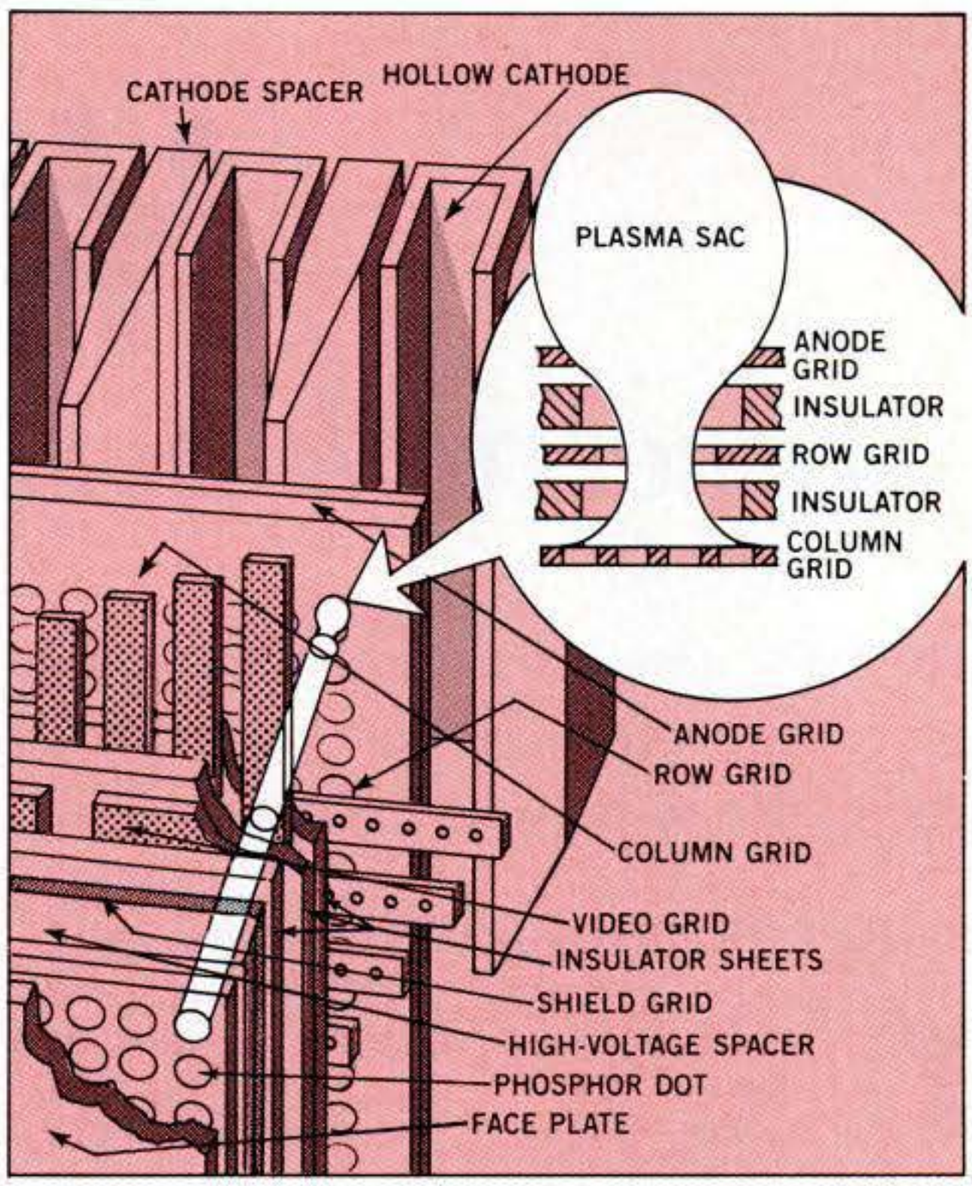
[Continued on page 112]

PS comparison table: quiet non-impact printers

Manufacturer	Model	Price($)[1]	Type	Resolution[2]	Print speed[3] Draft (cps)	Print speed[3] NLQ/LQ	Max. chars. per line	No. print-head elements	Graphics	Color	Interface[4]
ACT	Chromajet II	6,400	Ink-jet	140	270	—	132	4[5]	●	●	P
Apple	Scribe	299	Therm.-trans.	160x44	80	50 cps	80	24	●	●	S
	LaserWriter	6,995	Laser	300	—	8 ppm	—	—	●		S
Brother	HR-5	225	Therm.-trans.	72	30	None	80	9	●		S, P
Canon	F-60	499	Therm.-trans.	180	80	20 cps	180	26	●		S, P
	PJ-1080A	699	Ink-jet	72	37	16 cps	80	1[5]	●	●	P
	BubbleJet 80	n.a.	Ink-jet	144	220	110 cps	80	24	●		P
Corona	LP300	3,395	Laser	300	—	8 ppm	—	—	●		P
DEC	LN03	4,195	Laser	300	—	8 ppm	—	—	●		S
Diablo (Xerox)	C150	1,295	Ink-jet	120	20	None	80	4[5]	●	●	P
	EPM-API	3,995	Therm-trans.	203	—	6 ppm	—	1,680[6]	●		S, P, V
Epson	P-80[7]	249	Therm.-trans.	72	45	None	160	9	●		S, P
	P-80X[7]	379	Therm.-trans.	180	45	23 cps	144	24			P
	HS-80	449	Ink-jet	240	160	32 cps	160	9	●		P
	SQ-2000	2,295	Ink-jet	240	176	106 cps	132	24	●		S, P
Hewlett-Packard	ThinkJet	495	Ink-jet	96	150	None	142	1	●		P, HPIL
	LaserJet Plus	3,995	Laser	300	—	8 ppm	—	—	●		S, P
IBM	Quietwriter	1,395	Therm.-trans.	350	—	40-60 cps	132	40			P
	Quietwriter II	1,595	Therm.-trans.	350	—	40-60 cps	132	40	●		P
Okidata	Okimate 10	238	Therm.-trans.	72	60	None	136	9	●	●	S, P
	Okimate 20	268	Therm.-trans.	144	80	40 cps	136	9	●	●	S, P
PCPI	DaisyLaser	3,495	Laser	300	—	8 ppm	—	—	●		S, P
PrintaColor	TC1040	5,495	Ink-jet	120	279	45 cps	—	4[5]	●	●	S, P
QMS	SmartWriter	3,850	Laser	300	—	8 ppm	—	—	●		S, P
Quadram	Quadjet	495	Ink-jet	72	40	17 cps	80	1[5]	●	●	P
Radio Shack	CGP 220	699	Ink-jet	72	37	16 cps	80	1[5]	●	●	P
Siemens	PT-88	745	Ink-jet	144	200	75 cps	136	9	●	●	S, P
	PT-89	895	Ink-jet	144	200	75 cps	248	9	●	●	S, P
	PT-90	2,100	Ink-jet	240	400	200 cps	136	32	●	●	S, P

[1]Suggested list price; [2]in dots per inch; [3]NLQ/LQ = near-letter-quality or letter-quality, in pages per minute (ppm) or characters per second (cps); [4]P = parallel, S = serial, HPIL = Hewlett-Packard Interface Loop, V = capable of printing video images; [5]characters per color; [6]special in-line format for printing video; [7]for Epson Geneva portable





Lucitron's Michael DeJule views a computer-generated image of himself on the 35-in. panel he helped develop. Tiny ionized gas sacs (above) form at row and column grid intersections activated by voltage pulses. Voltage on the shield grids and phosphor attracts electrons from the sac to excite phosphor dots; a video grid regulates intensity.

35-inch flat-screen TV

is only 3 inches thick

Tiny globes of ionized gas march in step inside flat screens to paint TV, computer, or electronic-sign images. Military and commercial uses are planned. Home use? By the 1990s.

By JOHN FREE
Drawing by Harvey Woolhiser

At Lucitron Inc.'s small laboratory near Chicago I watched violet helium gas flicker in a thin glass panel. Lucitron officials, protecting new technology, wouldn't detail how the device worked. But during my 1981 visit they showed me a picture-frame-like electronic chassis to house these glass panels ["Flat-Screen TV," PS, June '81].

Now Lucitron (1918 Raymond Dr., Northbrook, Ill. 60062) has finally linked these components together into a 35-inch (diagonal) flat video screen —and revealed how it works. The monochrome panel, claimed to be the first practical hang-on-the-wall device of this size, is going to military customers, initially. Within a year, says Lucitron, a color version of its Flatscreen panel will be operating.

Flatscreen's key advantages are contrast range, brightness, low-cost electronics, and slim design. For military command centers or weapons simulators, panels can be easily suspended from a ceiling, hung on a wall, or set up like an easel. Civilian uses might include information displays for managers, tele-conferencing (two-way TV), electronic signs, education, and computer-aided design. Home use is feasible by the 1990s.

Lucitron's first panel has limited resolution (90,112 picture elements, or 256 rows of 352 phosphor dots), but higher-density panels are on the way. Within four years Lucitron expects Flatscreens to cost $4,000 instead of today's $40,000.

The key to panel operation is the clever manipulation of tiny plasma "bubbles," or sacs, at the intersection of row and column electrodes. "A sac acts like a big lens. It draws a lot of electrons out of the surrounding plasma and focuses them in one spot," says Michael DeJule, vice president of research and development. "So a plasma sac is actually a movable electron source."

Current Flatscreens use 22 narrow cathode panels, each with 16 vertical electrode columns. "It's like a CRT [cathode-ray tube] that has 22 electron beams rather than one electron beam," says DeJule.

Electrodes for every 16th column and every 10th row are connected. By applying carefully timed voltage pulses, 22 plasma sacs simultaneously move in a zig-zag pattern from top to bottom, exciting rows of phosphor dots. The technique saves transistors and greatly simplifies the drive circuits: Only 26 power drivers for all the rows and columns are necessary—even if their density is boosted to 1,024 rows by 1,024 columns. PS

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Hot new tires
—racetrack performance for your car

There's a new generation of tires that perform the way race-car tires did only a few years ago. However, these new tires for our fastest sports cars have astonishingly low rolling resistance to help fuel economy—and long-life treads, too.

By HERBERT SHULDINER

"The high-performance street tires of today are equal in quality to the racing tires of a few years ago," former world racing champion Jackie Stewart told me as we belted up at Goodyear's test track in Akron, Ohio. Stewart was preparing to find the wet traction limits of a new set of tires for the Chevrolet Camaro. To drive his point home, he proceeded to click off a half-dozen hot laps through a flooded handling loop. I had to hold on tightly as Stewart whipped the Camaro around the tight, twisting turns. "We're only hitting a top speed of about 55 mph," Stewart said, "but you can't go much faster through this course." It was fast enough for me.

Goodyear's employment of Stewart to test tires is symbolic of the hot international race developing among the world's leading rubber companies to perfect high-performance radial tires for the growing fleet of sporty cars in the U.S. The hottest tires in the world at the moment appear to be Bridgestone's Potenza RE71, Pirelli's P700, Goodrich's Comp T/A, and Goodyear's Eagle VR S (shown at right). Why the big push behind performance tires? "Automobile manufacturers will equip 14 percent of their car production with performance tires in 1985," says Michel Petiot, Michelin's vice president of sales. Other industry sources speculate that up to 30 percent of all cars built in 1990 might require them.

What exactly is a high-performance tire? Every rubber and car company has its own answer. The consensus points to a radial that has a high-speed capability of at least 130 mph (more about speed ratings later), a low profile of 45 to 60 (the tire's cross-sectional height divided by its cross-sectional width), and terrific handling and traction capabilities.

The newest high-performance tires are designed not only to give that kind of service, but also to have a tread life comparable with conventional tires (up to 40,000 miles). In addition, General Motors and Japanese car manufacturers are prodding tire makers to build in low rolling resistance for better fuel economy, low noise, and comfortable ride qualities. These new characteristics would seem to be impossible to achieve in performance tires, but the rubber companies are using tread compounding and tire-construction tricks to give the car manufacturers what they've specified. To find out how the tire makers achieve this magic, POPULAR SCIENCE reporters traveled to Akron, Europe, and Japan to test the new tires and interview the engineers who designed them.

Conveying an image

First finding: High-performance tires are a combination of engineering and image building. Yes, there's good reason for the wide-profile, short-sidewall construction of these tires. But tread designs seem to be used for conveying an *image* of "bite" as much as actual usefulness in aiding traction.

The muscular wide-profile look took shape in the early '70s when Pirelli introduced the "plus one" concept. Here's how it worked: If your car carried 165/70-13 tires, you could switch to 175/60-14 tires without any need to adjust your speedometer. You wound up with 14-inch wheels instead of 13-inch wheels and lowered the profile (sidewall height) of the tire. The wider low-profile tires gave cars a greater ability to generate high cornering forces and take turns at higher speeds. Then advances in polymer chemistry, computer-aided tire tread designs, and new construction materials and techniques brought improvements in wide-profile tires. But why are they better than high-profile tires?

"The reason we use low-profile construction in our Comp T/A," says Goodrich engineer Gary Derian, "is because it changes the shape of the footprint." (If you're curious to see what the footprint of your car's tires looks like, jack up the car ¼ inch and ink a tire. Then lay a piece of paper under the tire for an impression of the footprint.) A low-profile tire gives a shorter and wider footprint, while a high-profile tire (70, 80) makes a longer and narrower one. The longer footprint changes into a crescent shape at high speed and tends to squirm a lot—lifting parts of tread off the road. The short, wide footprint generally maintains its rectangular shape and resists squirm and distortion. So the low-profile tire can build up higher cornering forces and permit you to go through turns at higher speeds. High-performance-tire makers also design their tires with stiffer sidewalls, treads, and belts to assist in keeping the footprint on the road.

The drawback of the short sidewalls is that there is less cushioning of road bumps. "A good car suspension can compensate for that," Derian says. But sports-car drivers who use low-profile tires generally are willing to tolerate a less comfortable ride in exchange for better handling.

Most of the hot tires also use an aggressive-looking unidirectional tread —apparent in the Goodyear and much more subtle in the Bridgestone and Pirelli. Goodrich's Comp T/A does not have a unidirectional tread; Derian claims it isn't necessary for outstanding wet traction, and that's the main reason for using this type of tread.

"The new tires give dazzling performance," says PS auto editor Jack Keebler, who recently completed testing four of the hottest cars in the world. (You can read about it in next month's car test.) "I set the fastest times ever for the high-speed lane change—all on the first run for each

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car. And though I'm usually tense for this part of the test, with these cars and tires I was relaxed all through." One of the cars was equipped with the Goodyear Eagle VR50 and another had Bridgestone's Potenza RE71. A third car rolled on Pirelli's P7. "These tires make a tremendous difference in handling," he says.

Keebler also had an opportunity recently to test Pirelli's new P700 ultra-high-performance tire at the Jarama race circuit outside of Madrid, Spain. The P700, a successor to the P7, offers big improvements in performance, Keebler says after extensive road and handling course tests.

Developed for the Corvette

At the spacious new Goodyear Tech Center in Akron, Don Knight, manager of passenger-tire programs for the company, told me the Eagle VR50 was originally developed for the 1984 Corvette. Collaboration between car and tire makers is an increasing trend so that tire and chassis can be mated with more precision. "We got the specific objectives back in 1980," Knight revealed. "GM wanted a 50-profile tire to fit a 16-inch rim, a 143-mph speed rating [for the '86 Corvette, Goodyear has given the tire a 156-mph rating], and the best handling we could provide—no holds barred." But there was a catch. "GM also asked for a tire with low noise, full tread life [40,000 miles], and reduced rolling resistance so that they wouldn't be penalized by the gas-guzzler tax," he told me.

The natural place to look? Knight pointed to a Formula 1 racing rain tire beside him. "It has a tread pattern that looks like an alligator's back—large blocks for outstanding handling, and channels to get rid of water from underneath the tire," Knight said. Comparing the "gatorback" racing tire and the VR50, I could see the close resemblance.

The Eagle VR50 is certainly a hot performer: The tire can generate a lateral force of 1.01 *g* on the skid pad.

Fred Kovac, Goodyear's vice president of engineering, won't say precisely how Goodyear created the new tire. However, he says the major changes are in the tread compound, which has a depth of 9.2 mm (0.4 inch) to provide better traction and at the same time have long-wear characteristics. "You can't determine the recipe for a compound merely by analyzing the chemistry of the tread," Kovac says. "It's not only what polymers you put into the tread, but also the sequence and the duration of the cooking."

As good as the VR50 tire is, Goodyear last year discovered it wasn't

[Continued on page 114]

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Fastest bicycle in

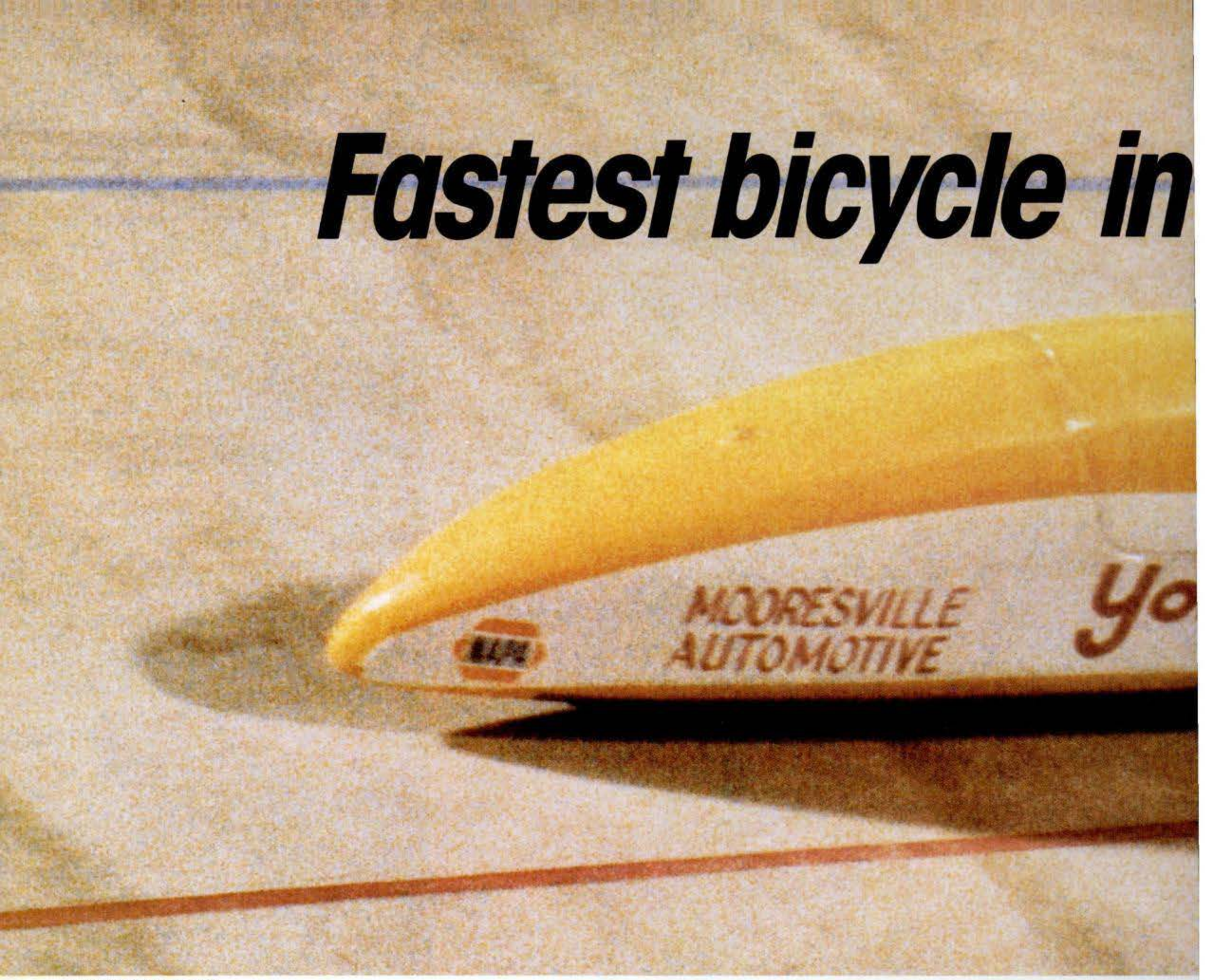

PHOTO BY RANDALL JOHNSON

PHOTOS 1-5 BY THE AUTHOR

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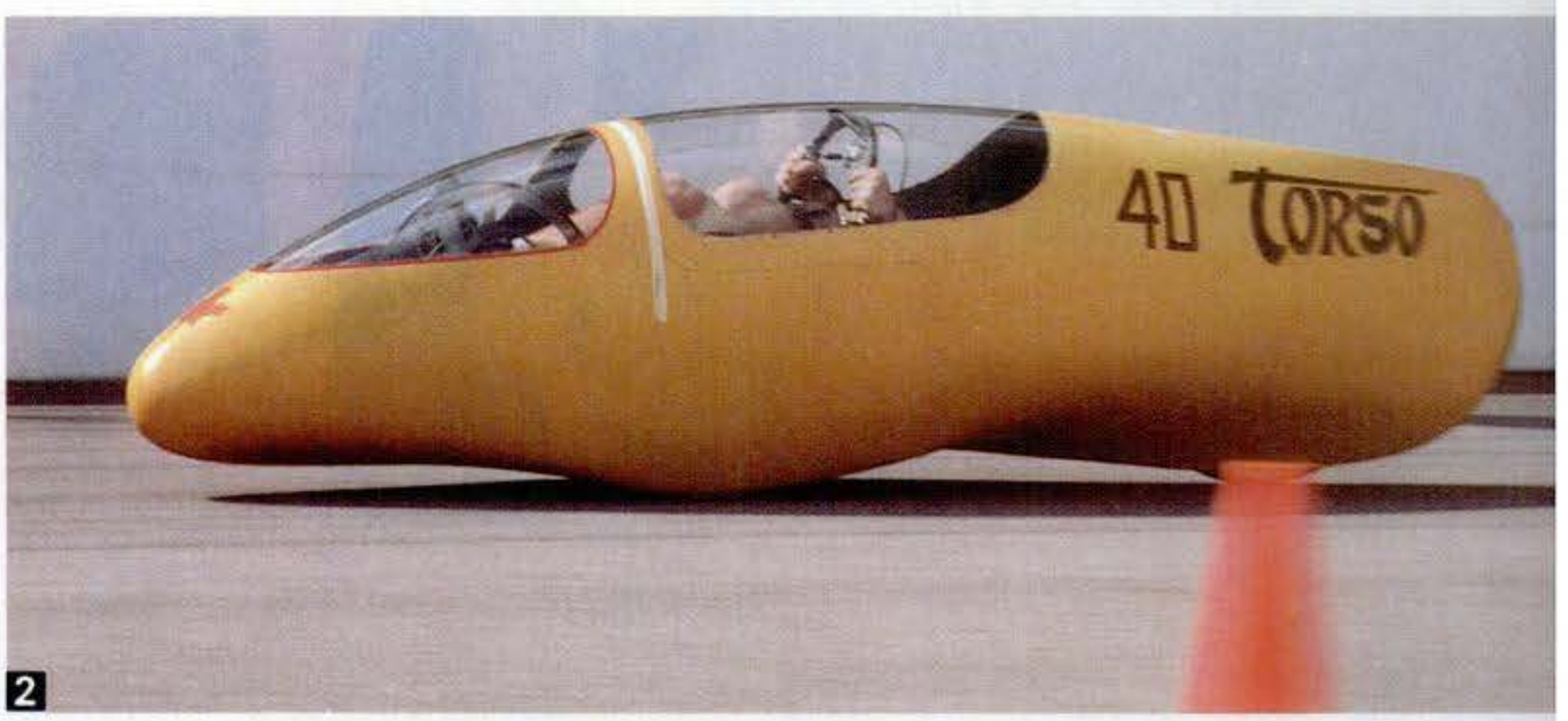

2

Human-powered-vehicle designers are relentlessly pursuing new speed records for unmotorized transportation. The competition is fierce; the world's record for two-wheeled vehicles has recently changed hands twice.

By STUART F. BROWN

This is work. With two human legs as the sole source of power, pushing a streamlined speed-record bicycle even 1/10 mph faster is like hammering on a brick wall with your bare fists—except the wall is the atmosphere. Like the bricks, it doesn't want to get out of the way.

As I witnessed recently at the 11th annual speed championships held at Indianapolis Motor Speedway by the International Human-Powered Vehicle Assn. (IHPVA, Box 2068, Seal Beach, Calif. 90740), builders of human-powered vehicles (HPVs) are boundlessly inventive in their quest for ever-higher speeds. In the past several months their

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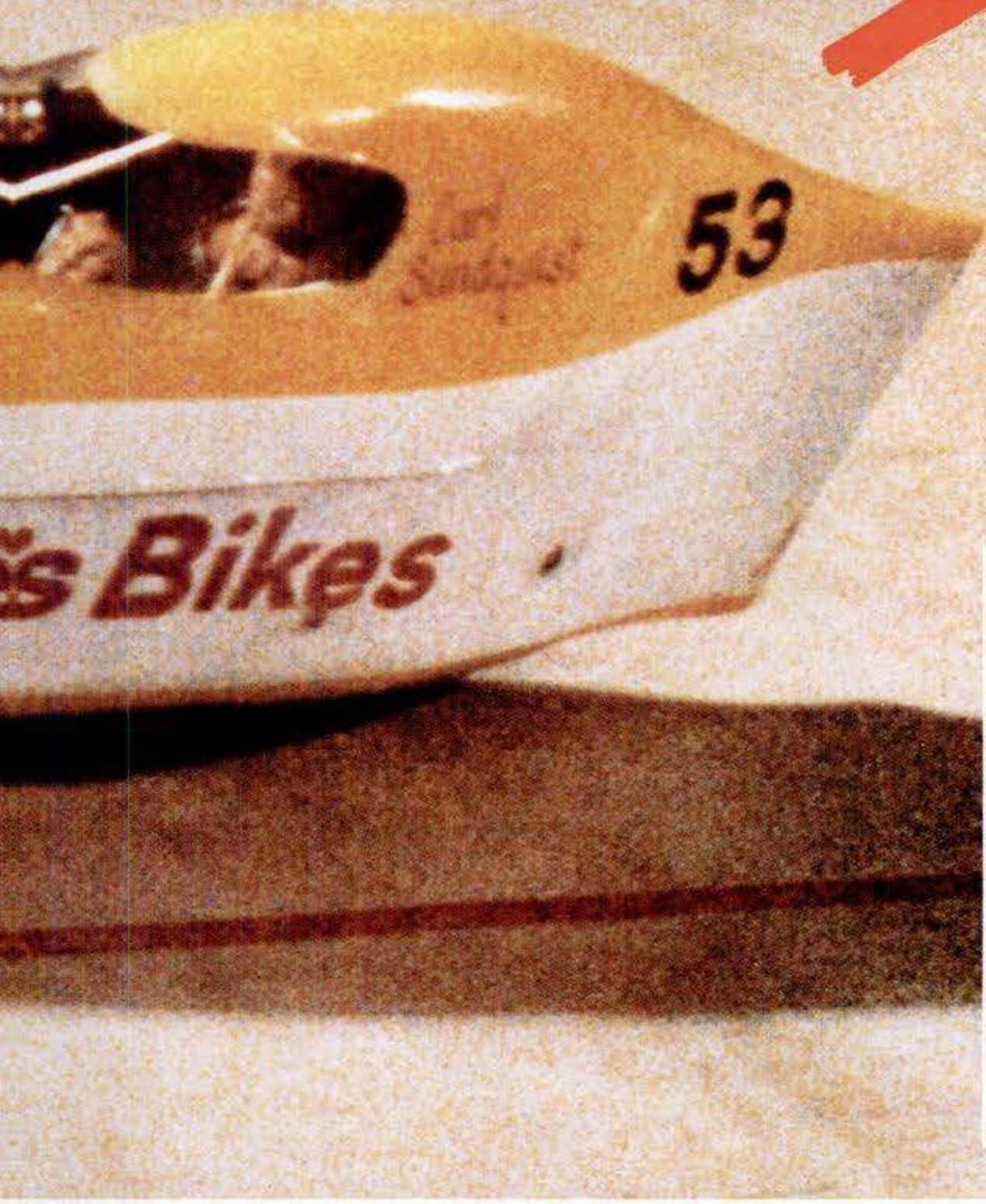
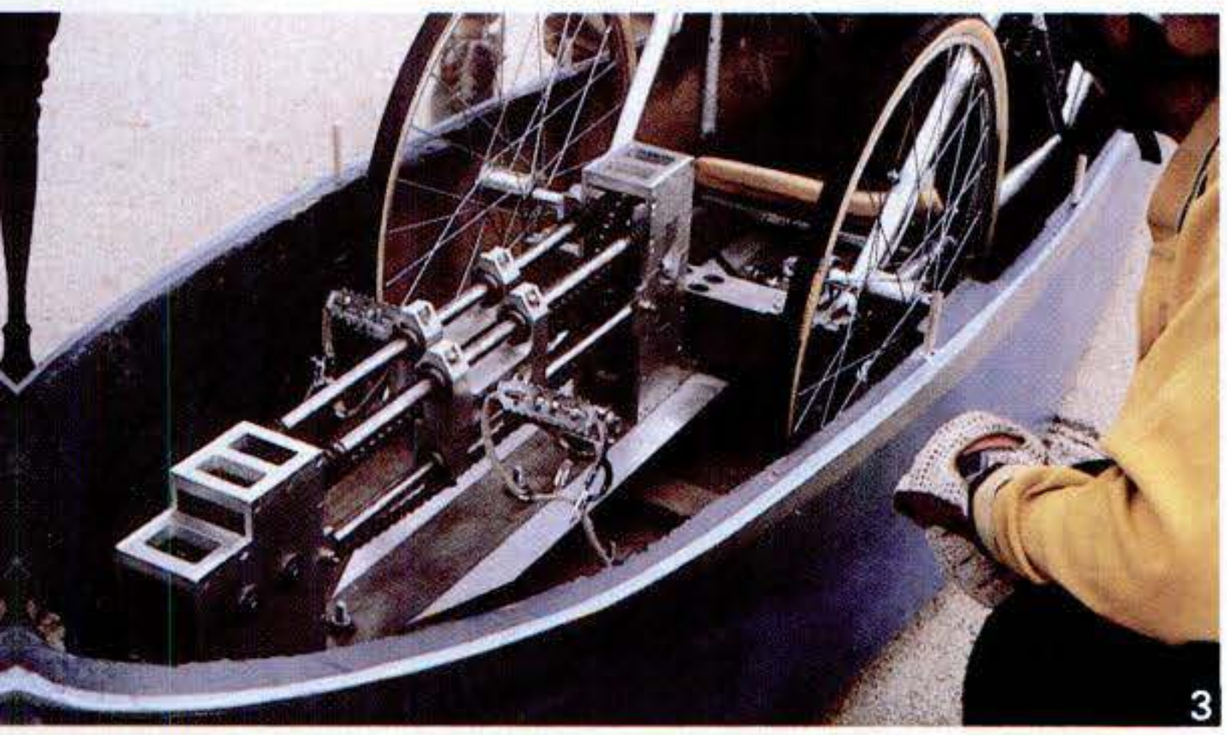
61.44
the world: ~~59.12~~ mph





An HPV sampler: Carl Sundquist pedaled Moby 3 (large photo) to a short-lived record of 59.12 mph at Indy. The Kevlar-bodied two-wheeler was built by Terry Hreno, who teaches art in an Indiana prison. Fore! (1), built and ridden by 57-year-old Arthur F. Toplis, clocked in at 33.85 mph. Georgi Georgiev of Toronto built the beautiful monocoque tricycle Torso (2), which was pedaled through the timers at 44.63 mph by Orrin Bowser. Sam Wildofsky got the trike Argo (3), with its clever linear-drive pedal mechanism, to go 34.36 mph. Shown with "landing" doors open, Jon Stinson's Stinson Flyer (4) went 44.14 mph. Dentist David Pearson and Sharon Smith built Doctor's Orders (5), which she pedal-powered to a 35.27-mph track run.

sleek creations have twice knocked over a world's speed record for two-wheeled vehicles, set at the 1984 Indy meet by Tim Brummer's 57.91-mph Lightning X2. I found the motorless aerodynamic speedsters ["Man-Powered Racers," PS, Oct. '80] endearingly quiet as they whooshed past during their flying-start 200-meter time trial runs.

When Terry Hreno's Moby 3 made its 59.12-mph record run at Indianapolis, the builder was ecstatic. Exulting in the pits after the results were announced over the loudspeakers, Hreno crowed: "We did it. I can't believe we finally

[Continued on page 116]

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Self-sufficient

The old screened porch above was replaced with the expanded structure at right, and the tiled patio was added.

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sun room

A sun-room addition can add living space without increasing energy costs. This south-facing porch was transformed into a bright entertainment area that requires no heating.

By AL LEES
Drawing by Carl De Groote

The owners of this Illinois home knew they wanted more space for entertaining and relaxing. They also knew they weren't willing to put up with higher heating bills to keep a new addition warm during winter.

The solution? Unlike the "Vaulted Sunspace" featured in last month's issue (a two-story addition grafted onto a specific house design), the passive sun room they've come up with could replace a south-facing porch on virtually any home. It boasts a quarry tile floor that absorbs and radiates warmth from sunlight streaming through sliding glass doors facing south and east. The mini-blinds behind the glazing are fully raised on sunny winter days but closed at night to conserve the warmth soaked up by the dark masonry flooring (Lava Red quarry tile, available at Color Tile outlets). On such days, the sun room remains comfortable well into the evening, without any backup heat. Beyond this self-sufficient corner, extra space was added to an existing family room by knocking out most of a wall. The house's existing heating system was adequate to keep the expanded room cozy when the sliding door between it and the sun room is kept closed. (Note that on the floor plan, all four walls of the sun room have a sliding glass door.)

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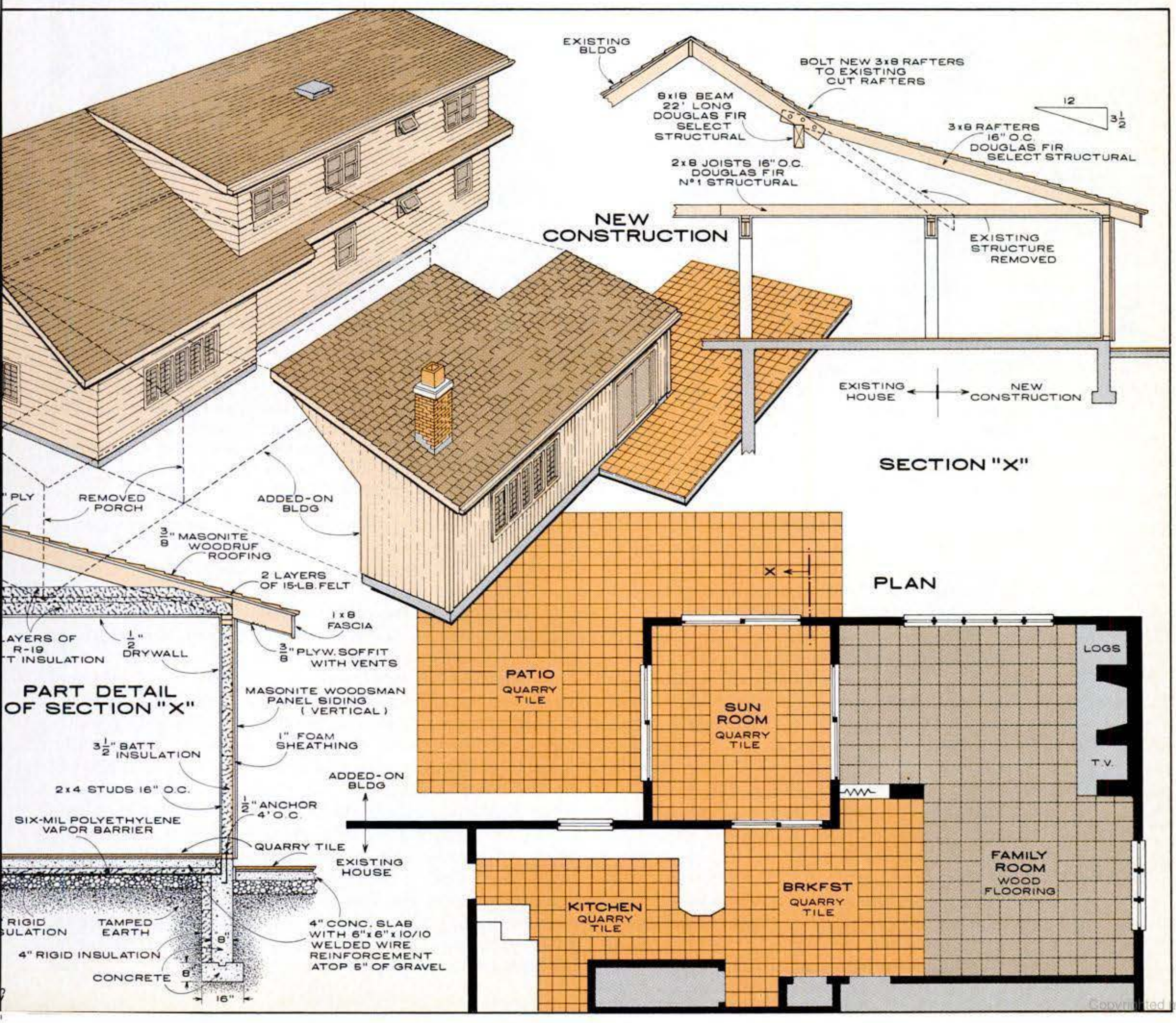

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Walls are framed flat on the slab, and insulating sheathing is nailed in place (1). Walls are raised and propped vertically while corners are joined. Note the angled corner brace let into the studs of the far wall (2). Masonite's Woodruf wood-fiber shingles were used to roof both the sun-room addition and the existing house. The patio slab is stepped down from the sun-room slab (3). Tiles are set in rows on the adhesive-coated slab, leaving space for grout lines (4).

Cut the tiles with a tile cutter to fit along walls by scoring the tile and snapping it in half. When applying grout, work it thoroughly into joints. Remove excess grout first with a wet sponge and later with a dry abrasive cleaning pad. The same tiling technique was used on the outdoor slab. A 3-in. step-down and slight pitch prevents puddling or freezing against the glass-door sills. If other than quarry tiles are to be used outdoors, be sure they're frost-proof.

The homeowners began by dismantling the old screened porch shown in the "before" photo. The material was left at the site so lumber could be salvaged to reduce costs.

A trench for footings and foundation was dug beyond the perimeter of the existing porch slab. Because the sun room was to be independent of the home's heating and air conditioning, that part of the extension was insulated with rigid foam, as shown in the section below. The sun-room slab was poured over two inches of foam so that the heat it absorbed wouldn't be lost to the earth beneath. Once the forms were removed from the extension floor slab, a stepped-down patio slab was poured, with simpler footings pitched slightly away from the house for drainage.

After the walls were raised, a new roof was added —spliced into the cutaway existing roof—with both new and cutaway rafters butting against an added support beam. The roof over the sun-room section ties into the house's second story, with the rafters notched over a ledger lag-screwed into existing studs. For efficient solar heating, the homeowners dropped the ceiling of the sun-room area and packed the space above with insulation. Over the adjacent family room, the drywall ceiling was nailed directly to the bottom of the new rafters for a cathedral effect. (R-19 fiberglass batts were stapled between the rafters first, however.)

Masonite wood-fiber shingles were chosen for the roofing, and because these 12-by-48-inch strips nail up quickly, it was no chore to re-shingle the existing roof to match. To complete the exterior, Masonite's Woodsman textured panel siding was applied to the walls. Besides complementing the appearance of the roof, the high-density siding material adds somewhat to the insulation rating of the walls.

Energy efficiency was of prime importance in the selection of materials for the sun room's interior. The walls were insulated with 3½-inch batts, which were then covered with a vapor barrier of six-mil polyethylene stapled across the studs. The quarry tiles are thermally coupled to the heat-storing masonry mass beneath.

Installation of the ½-inch-thick tiles is simple; all the tools necessary are available from tile specialty outlets. After grouting, coat the surface with silicone sealer to prevent dirt and moisture penetration. PS

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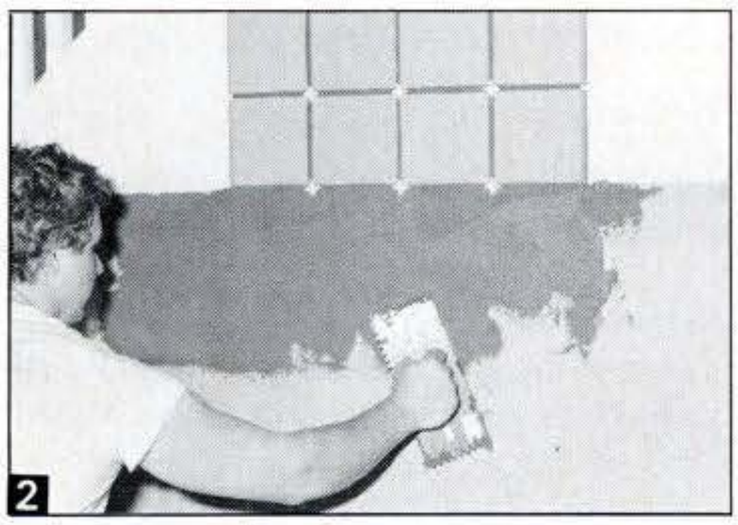
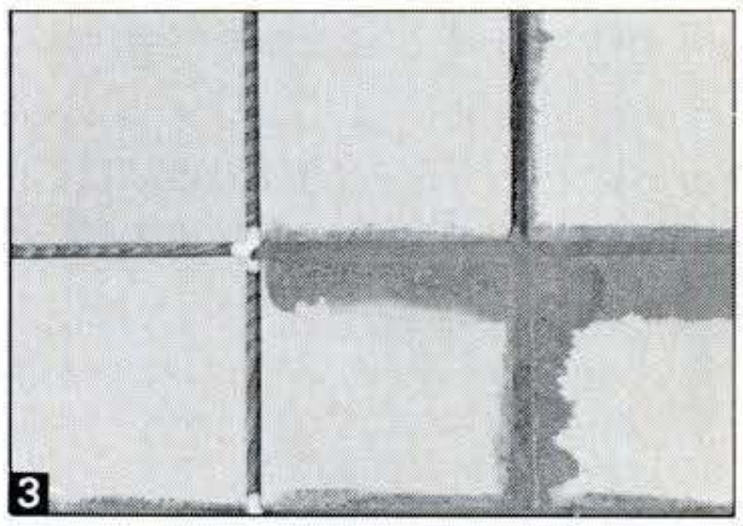
Tiled wood-stove guard

A tiled guard makes an attractive backdrop for a wood stove (right). Use screws to secure Durock to the furring strips (1). Tile should be cut and ready for installation before you trowel on the mortar (2). Rake the trowel's notched side over the mortar to create an even layer of adhesive. Use ⅜-in. plastic spacers to align tiles (3). Let the mortar cure for 24 hours, then trowel a light-color grout—which won't readily show ash smudges—over the spacers.





By MICHAEL BARGO JR.
Photos by the author

Fourteen million homeowners rely on wood stoves as an economic, pleasant way to keep a place warm. But a stove also radiates a potentially dangerous amount of heat to the surrounding combustible walls and floors. Until recently, most wood-stove guards were made by tacking up asbestos millboard or sheet metal—an unattractive and, in the case of asbestos, possibly unhealthy solution.

Now there's Durock, a heat-resistant cement-based board from Durabond Div., USG Industries (101 South Wacker Dr., Chicago, Ill. 60606-4385). This new U.L.-listed board makes an ideal wood-stove guard that's easy to secure to the wall and floor. And you can cover Durock with any decorative material—as long as it's heat resistant. For example, I chose to face the board with quarry tile. The result? An inexpensive route to a handsome wood-stove guard.

Building a tiled guard is easy. First, set the stove's location. Many local building codes specify that the stove sit at least 12 inches from a wall and that there be 14 inches between the wall and the stovepipe. Generally, the wall shield must extend eight inches on each side of the stove. The floor guard typically extends 18 inches in front of the stove, and eight inches from the back and sides. Make sure your installation complies with local codes for solid-fuel room heaters.

Start your installation with the wall shield. The ½-inch-thick Durock should have an inch of space behind it so that air circulation will prevent heat buildup. You can create furring strips to nail over wall studs by ripping three-inch planks from a sheet of Durock and doubling them up. Use a circular saw with a carbide blade.

You will also need a vent at the bottom of the wall shield to ensure airflow there. So start the wall guard 1⅝ to 2⅝ inches from the floor.

Finally, install the Durock sheets horizontally across the furring strips using three-inch drywall screws to penetrate the studs.

There's a slightly different procedure for the floor guard. You have to install Durock on a bare wood or cement floor, so begin by cutting away existing carpeting or vinyl flooring. Then clean the exposed floor, and cover it with a ⅛-inch layer of thin-set mortar that is mixed with latex.

Lay the Durock in place. The mortar will hold the board flat against the floor so no heat-collecting pockets can form. Secure the boards with drywall screws or 1¼-inch galvanized roofing nails every eight inches.

Now you're ready to tile. I used six-inch-square, ½-inch-thick quarry tile which is easy to clean—an important feature because ashes often manage to escape from a wood stove. (My supplier: Summitville Tiles, Summitville, Ohio 43962.) You can use almost any ceramic tile, however, because most are fired to 1,900 degrees F—far hotter than the heat from a stove. To be sure the tile you choose will hold up, check with the dealer or manufacturer.

Spread the latex-modified thin-set mortar over the wall area first. I tiled mine in sections, but you can do the whole wall shield at once. Lay the first tile at the center top of the guard, then work toward the sides. That way you'll confine any needed trimming to the side tiles. Set the tiles firmly in place with a slight twist. For the floor protector, start tiling at the front of the guard—the side farthest from the wood stove—and work toward the back. PS

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A boat for all reasons

Sail, scull, troll, and row this easy-to-build cartopper

Inspired by a new breed of multi-use boats, this 14-footer has three cockpits, a transom for motor or rudder, and a double-deck track for snapping on oarlocks and cockpit covers. The all-plywood boat uses standard hardware-store fittings, and costs $450 to build.

By SUSAN RENNER-SMITH
Drawing by Eugene Thompson

"This is all the small boat you need," says Peter Stevenson, designer of the clever craft shown here. "Sailing performance is flat-out fast. Even the wind surfers have to pay attention or they get passed."

Inspired by the new generation of multi-use boats like the Saroca ["New Products for Recreation," PS, May '85], Stevenson's boat converts quickly from sailboat to canoe, rowboat, or (with a small outboard) powered skiff. But the Stevenson boat has more deck area and is two feet shorter than the Saroca, for easier car-topping. And the boat costs $450 to build, compared with about $3,600 for a fully equipped Saroca.

Complete plans cost $10 from Stevenson Projects (Box 584, Del Mar, Calif. 92014), but an experienced woodworker can use the plans shown. The deck and keel each take two panels of ¼-inch plywood—note the staggered joint lines in the plans. Mark the dimensions given carefully (they define the hull curve), then cut the panels.

Next glue and screw the skeg along the center line on the bottom panel's under side (see exploded view). Stevenson uses one-inch No. 8 plated flathead wood screws every three inches and recommends Wilhold Waterproof Plastic Resin Glue.

Use the same fastening method throughout, attaching the bulkhead thwarts—kerfed to follow contours—to the inside bottom panel. Then set the bulkheads in place, taking care to fasten each at the angle shown, and attach stringers to the bottom-panel edges.

Assemble and install the forward cockpit brace (including the mast step), center cockpit sides, and daggerboard box. Fasten the motor mount to the front of the transom, then stuff blocks of foam flotation into the fore, aft, and side compartments.

Preassemble the deck, attaching the stringers, panel joiners, and cockpit braces to the underside. Set the deck in place, fitting the stringers into the bulkhead notches; then fasten the deck to the bulkheads and transom. Attach the stem.

Cut the sides oversize, tack them in place, and scribe cutting lines from stem to stern. Trim the sides slightly oversize, and fasten them in place, making sure to offset the screws from those used on top and bottom. Sand the sides flush with the deck, and round the corners. Extend the daggerboard box slot from the box into the top of the deck, and paint the hull with several coats of good-quality epoxy paint.

To make mounting tracks for the

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Skiff can be sailed (right) or paddle powered (insets). It launches easily (above).

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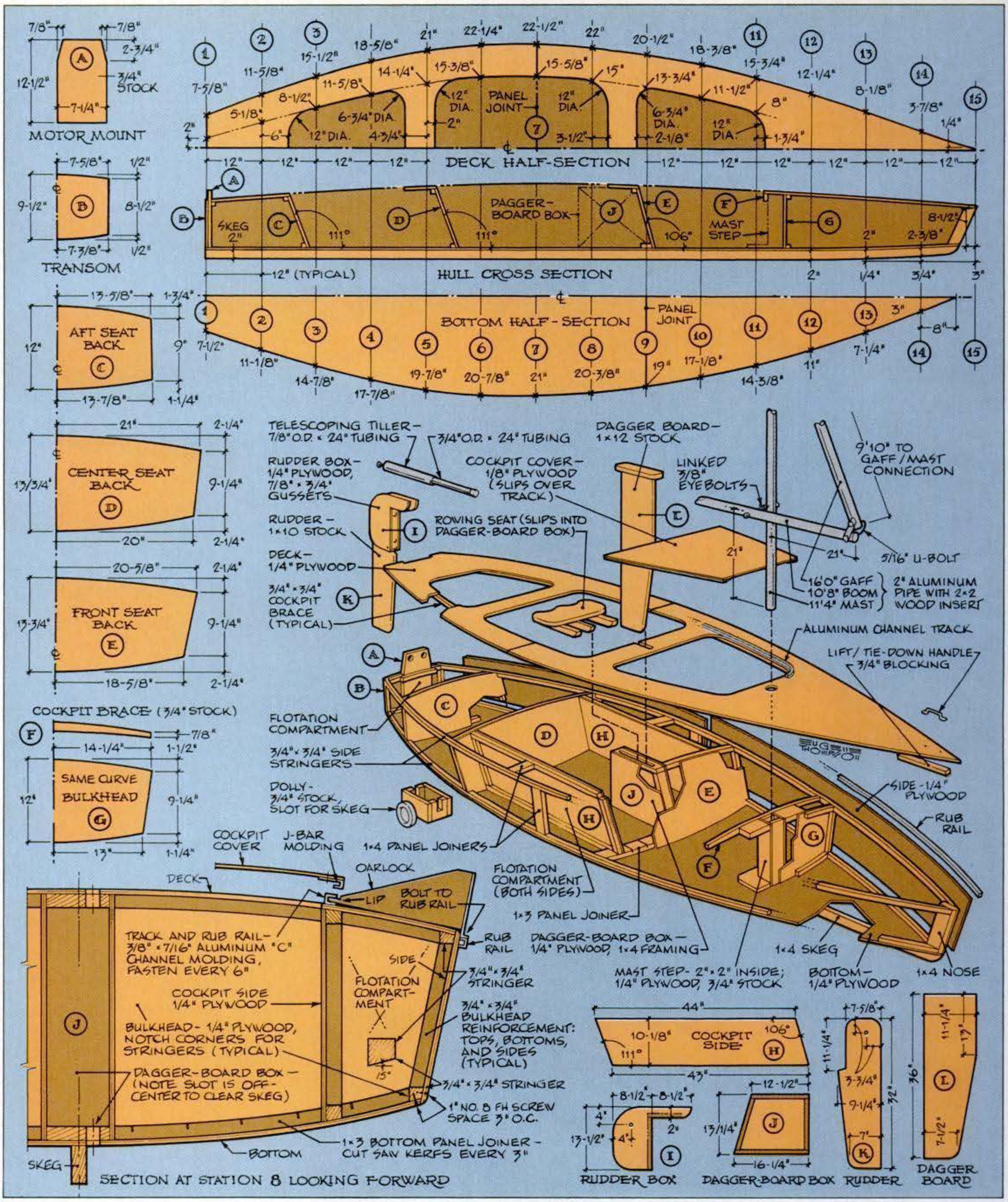

oarlocks and hatch covers, bend and shape an aluminum channel molding to rim the cockpits (see drawing). Lay the molding on its side, countersinking screws every six inches. Mount a second channel to the hull sides.

Make the dagger board, rudder, and rudder box using the dimensions given. For a quick-release rudder, attach a barrel bolt and hasp to the rudder box and mating hardware to the motor mount.

For a no-sew sail, use rip-stop polyethylene tarp. Spars made of two-inch aluminum tubing slip into pockets made from a lace-up flap reinforced with duct tape on each side.

The rowing rig includes a row seat and unique tetrahedron-shaped oarlocks. The seat has three underseat braces—the center one fits into the dagger-board slot, and two outer ones straddle the dagger-board box. The oarlocks stretch from cockpit to rub rail (see photo). The inboard edge notches into the cockpit track, and the far edge clamps to the outer track.

Add oars, paddles, and a small outboard, and you have a complete, low-cost water-sport package. PS

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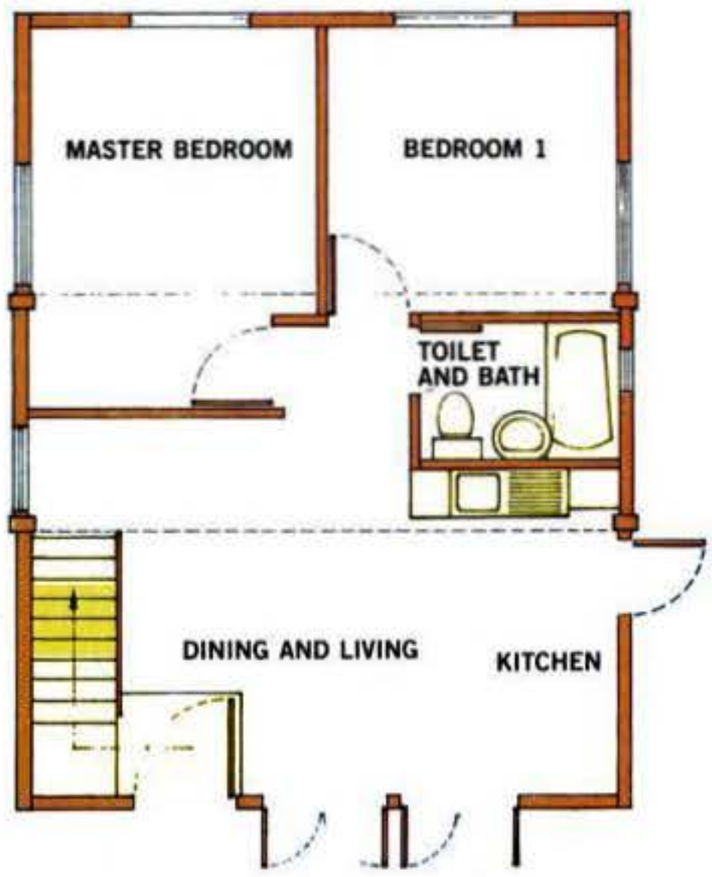


House in a box

A 20-foot-long shipping container packed with prefabricated building components can be assembled in a week by a four-man crew into a cozy two-story 700-square-foot cottage.

By STEVEN ASHLEY

Need a low-cost home in an area where building materials and construction crews are scarce? For $25,000 plus transportation costs, a Canadian builder will ship you a 20-foot-long cargo container with just about everything you need to assemble a two-story 700-square-foot cottage. Nothing is wasted, not even the steel shipping container—it serves as the main support for the structure.

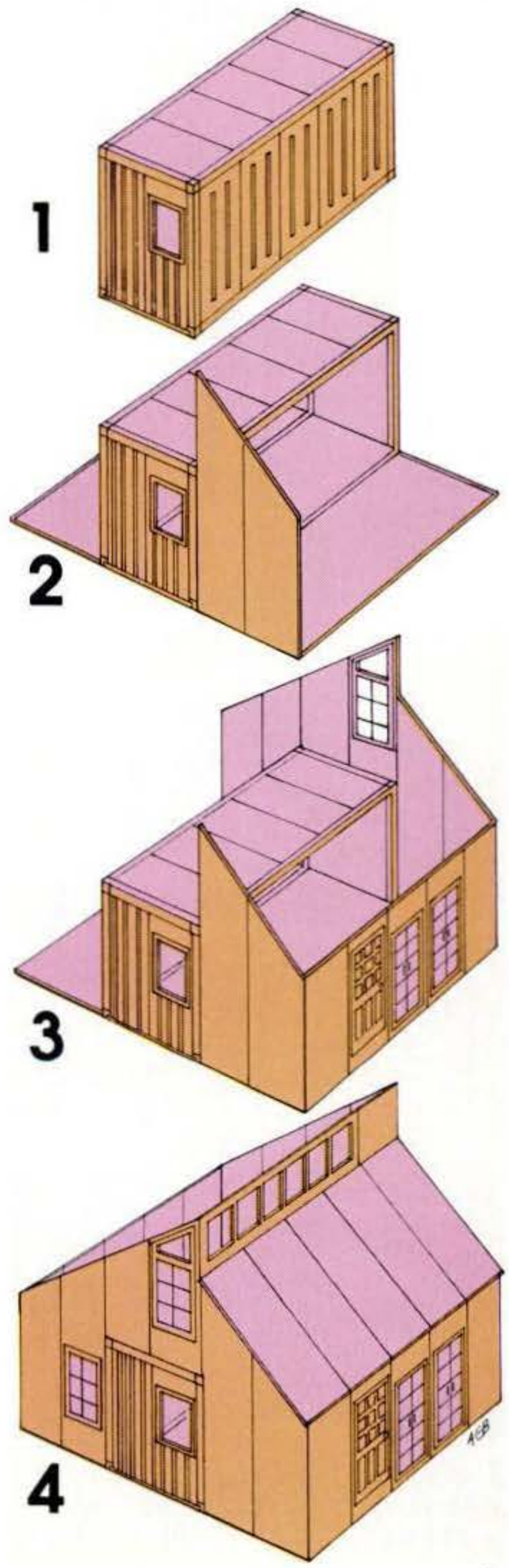
Jivan Holdings Ltd. (221 Fifth St., Prince Rupert, B.C. V8J 3T2) has developed a small prefabricated house with two bedrooms, living-dining area, kitchen, bathroom, and loft area that can be shipped just about anywhere an 18,000-pound cargo container can go, says Jim Palibroda, the company's president. The houses are manufactured by Union Container Co. at an automated plant in Taiwan and sent by ship to the customer. The cost of shipping a house from Taiwan to Vancouver, for instance, is $1,530.

A four-man crew with a forklift and simple hand tools will erect the structure in about a week for an additional fee, Palibroda explains, but complete instructions for the do-it-yourselfer are also provided.

Set upon a 20-by-27-foot slab of concrete blocks, the steel container unfolds to reveal prefinished ½-inch plywood panels that form the outer walls and room partitions. The latter can be configured as desired. The fiberglass-insulated walls have an insulation value of R-12, and the ceilings are R-20. Paint, caulking guns, screws, and fittings are supplied.

The house comes completely prewired (100 amps), with all the plumbing ready for installation. Among the included items: wood-grain-exterior kitchen cabinets; a one-piece fiberglass bathroom unit; complete drainage piping for basins and toilet facilities; vinyl flooring; electric baseboard heat; French-style double-glazed windows; and there's even a kitchen sink.

The Afford-A-Home design, which Palibroda says is patterned after a western-U.S.-style cottage, with a pitched roof and clerestory windows, conforms to Canadian national and most local U.S. building codes. PS



Afford-A-Home (above) unfolds from a cargo container (1) that encloses prefabricated plywood wall panels and fixtures. They are assembled as shown (2, 3, 4). Ground floor plan (above left) can be configured in different ways.

DRAWINGS BY ADOLPH BROTMAN

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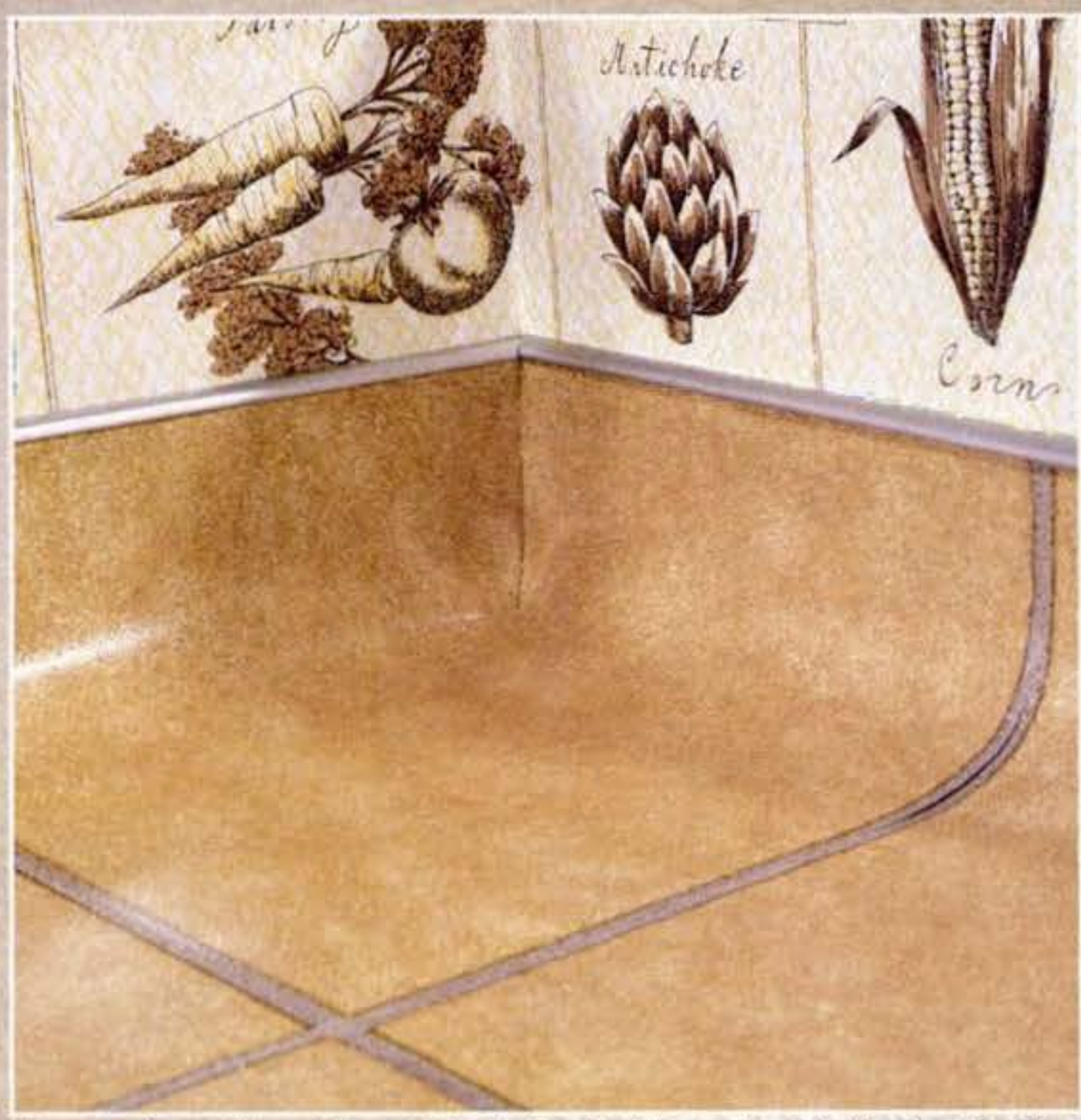
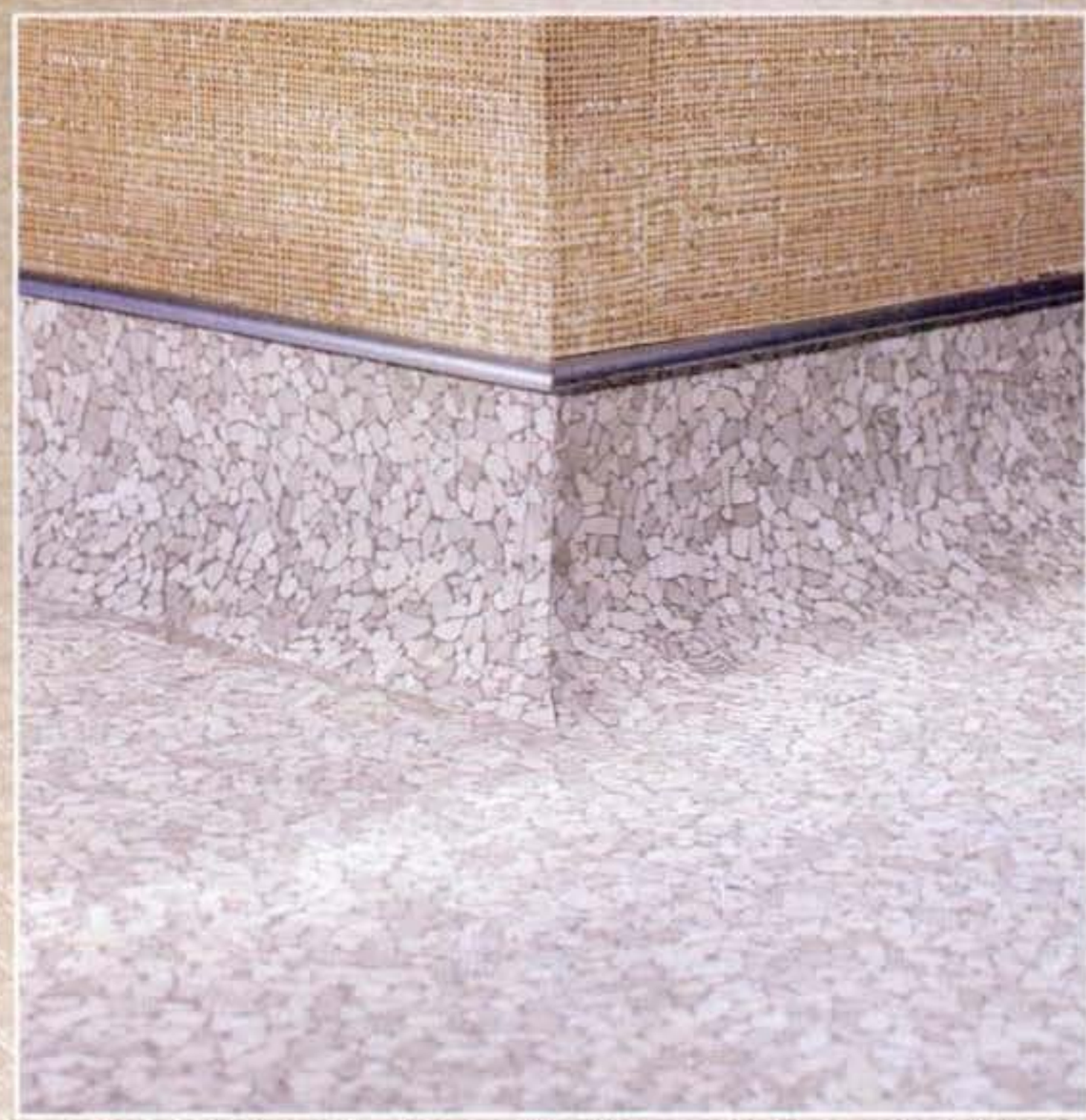
For truly seamless flooring—

lap it up the wall





Lapped up the side of the tub platform (top), Tarkett's Response vinyl flooring creates an elegant, seamless approach to the step-up bath. Careful cutting produces the compound curves needed to fit vinyl coving into an inside corner (above left). Outside corners (above) are patched, but beveled joints on precision-fit patch are nearly invisible.

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Professional installers often extend sheet vinyl flooring up the wall to form an elegant coving. Now homeowners can get the same seamless effect, using patterns supplied by POPULAR SCIENCE.

By R. J. De CRISTOFORO
Drawings by Nina Wallace

Professional installers of sheet floor covering are a close-mouthed group. I discovered this when I sought advice on coving the floor covering up the wall instead of butting it at the base. If you run the flooring up the wall, you don't have to install those dull-looking vinyl baseboards. Coving also dispenses with dirt-catching corners—and it gives a rich, unified look to the room.

But ask a professional installer for tips on cutting the compound curves required, and you get a quizzical look. These pros work by eyeballing the cuts, and it takes a lengthy apprenticeship to learn the technique.

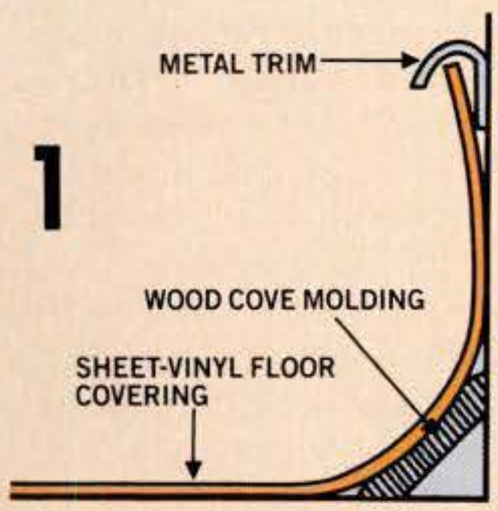
Because I wasn't interested in learning the job as a vocation, rather in doing it successfully in my home, I worked out patterns for the critical cuts. The patterns can be adapted to most installations—but remember, not all corners in rooms are square, and not all walls are purely plumb. Cut your patterns a bit oversize to allow for shaving for a perfect fit.

Begin the job by making a paper pattern of the floor's perimeter, cutting so the edges are about ½ inch away from all vertical planes. Mark all areas—inside and outside corners and projections—where you'll need a cutout pattern.

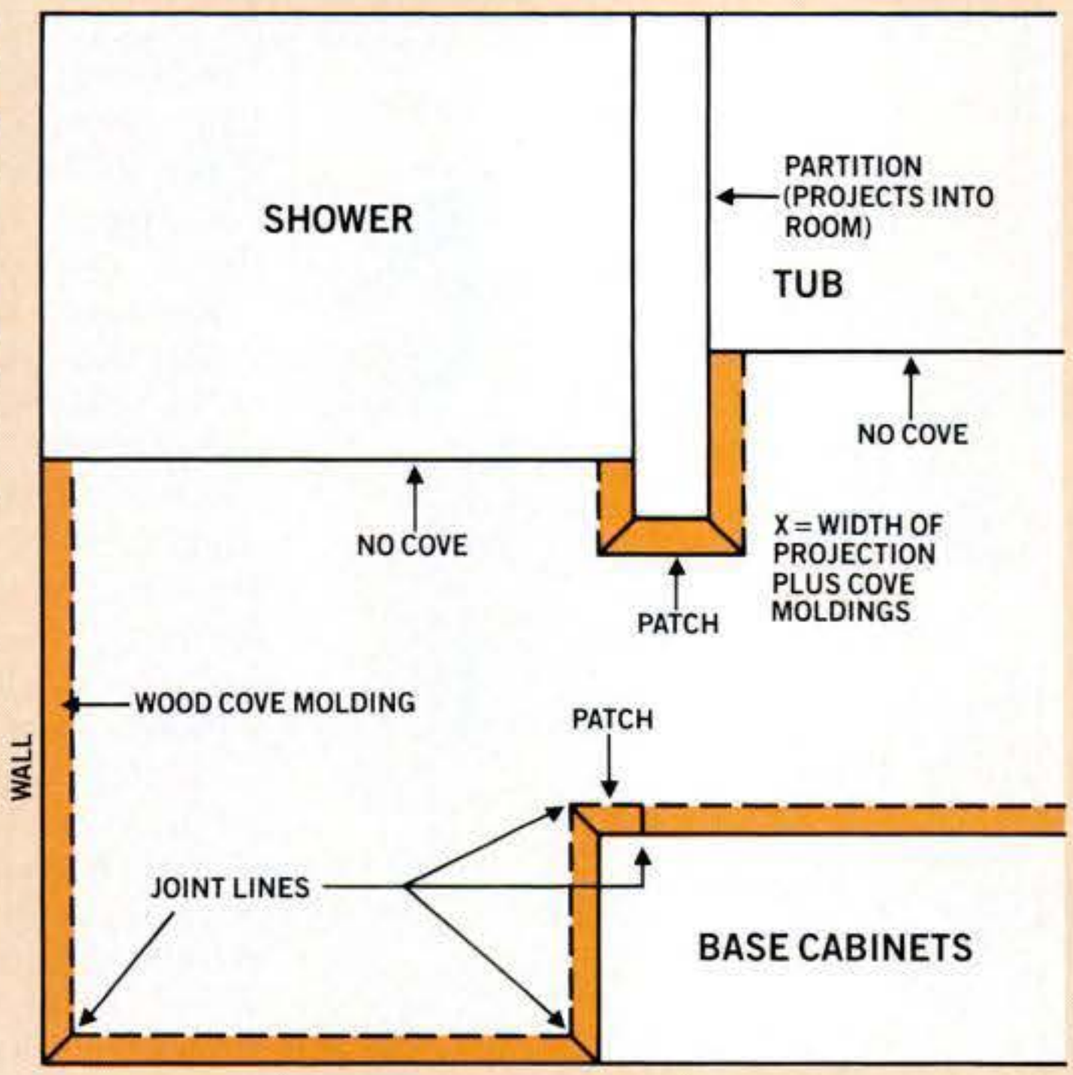
Next spread out the floor covering in a space that's large enough for it to flatten, then tape down the perimeter pattern. Where you want the floor covering to cove up the wall (see diagram), mark the cut line on the flooring about 3½ inches away from the paper-pattern edge.

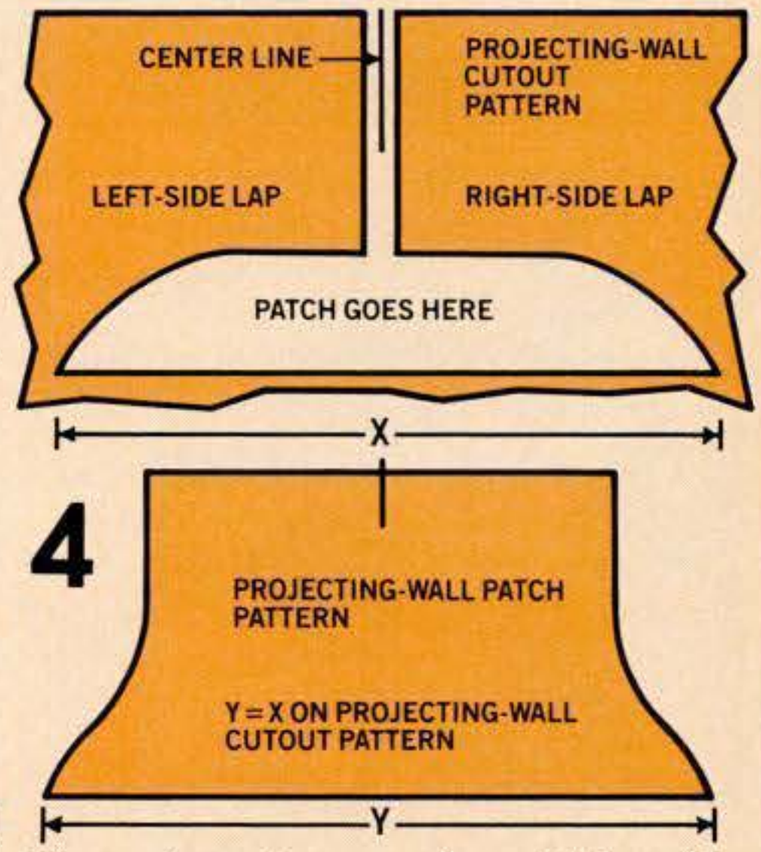
Scale up the corner cutout patterns, and test-fit to the actual corners be-

Continued

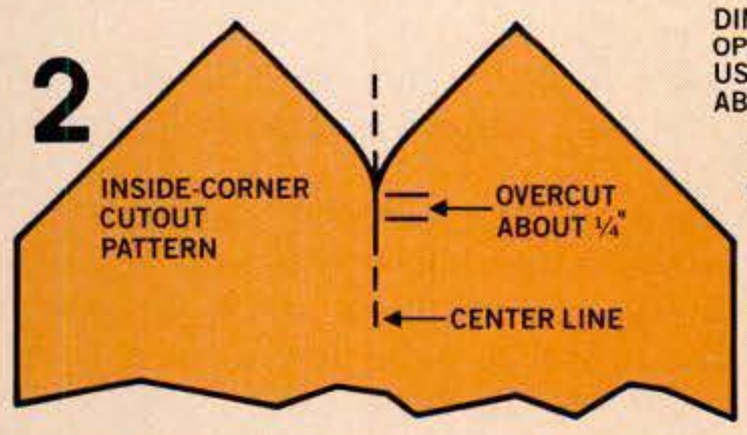


Coving cross section (above) reveals flanged metal trim hooked over flooring and wood-molding support from beneath. To prevent water seepage from splashes, flooring in bathroom (right) has no coving at tub and shower.

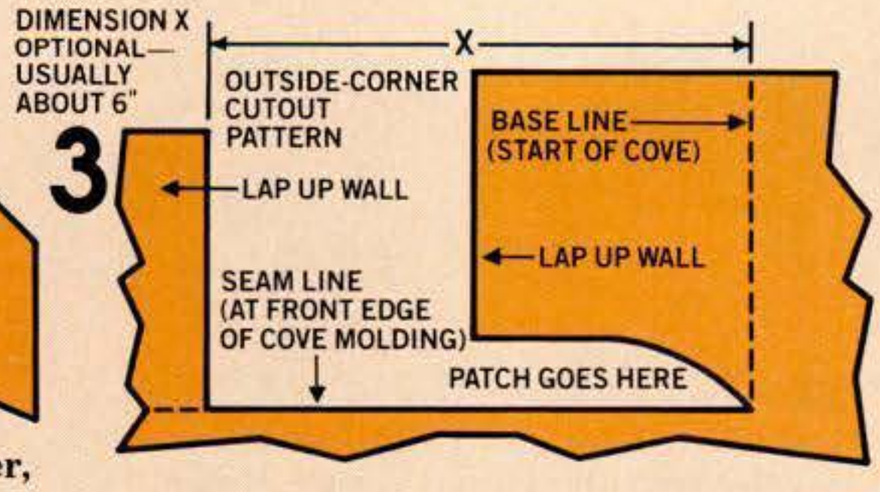




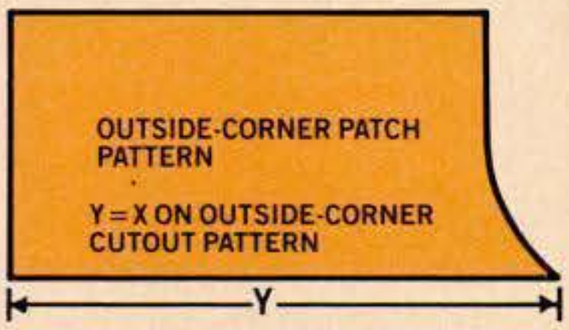
Dimensions given are for a 6½-in.-wide projection for a plumbing wall (a 5½-in. stud plus two ½-in. wall boards). Change dimension X to fit the width of your projection. Patterns serve as guides for cardboard templates you make and test-fit—the curve will depend on the height of lap up the wall. Cut the patch oversize, and shave to fit.



To cut flooring for an inside corner, make several light scoring cuts along a marked pattern line, then cut with a knife held at a 45° angle. Test-fit, then shave off the excess with lengthwise strokes of a sandpaper block.



An outside corner requires a patch and an intricate flooring-material cutout. The cutout allows the curved flap to fit up against the wall corner line, while the flooring turns the corner lying flat



on the floor, then laps up the wall again. The patch's straight edges butt against the wall lap and floor line, and the curve mates with the flap that bends up the corner line.

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fore marking the pattern on the flooring. I used a felt pen for this job—the broad line provided enough extra material to shave for precise fitting when installing.

Before laying the flooring, you should also prepare the support for the coving. To give the flooring shape and support, professionals cover the joint between the floor and wall with a wood cove molding, mitering it at the corners and nailing it in place. The miters don't have to be perfect, but don't leave big gaps. If you err, use wood dough as a filler.

To clamp the coving in place and cover its raw edge, use aluminum trim, available in silver or bronze at flooring-supply stores, which also sell the molding. When nailing trim to the wall, set it against a line drawn about 3¾ inches up from the floor, and drive nails at the base of the slots. This lets you tap the trim down to cover the flooring after it's installed.

Miter the trim carefully at all inside corners, but you can bend-miter it around outside corners, as the pros often do. Use a square file to form a V at the bend area. Then bend the material to form a 90-degree corner. If this system seems bothersome, just use the cut-and-fit method everywhere.

A popular preference among installers is a common utility knife with interchangeable blades. Straight blades and those with a hook are the most useful—but keep a supply on hand. Dull blades will cause problems.

Most of us hold a knife too timidly. Grip it firmly, enclosing it in a fist with the thumb extending a bit so it can act as a depth gauge. You can use a straightedge on the straight cuts, but you must work freehand on the curves, so it's a good idea to do some practice cutting on scrap material.

Make a light scoring cut first, then repeat it to emphasize the cut line. Lift the material, and follow the scored line with a through cut. It helps to have a board under the material for support close to the cut line.

Carefully follow the marked line with several scoring cuts, and make the through cut while holding the knife at about a 45-degree angle. This is necessary so mating edges at joints will fit correctly. Don't worry about cutting the exact angle at this point —you can shave and fit the patch as you go.

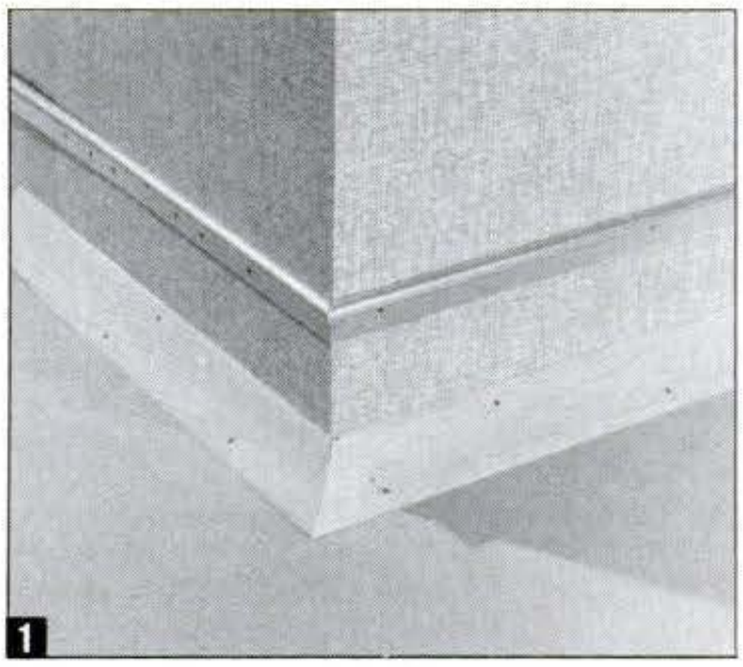
You can shave off excess with a knife, but a more cautious method is to work with a smooth file or with sandpaper wrapped around a small block. Stroke away from the surface if filing, lengthwise if using sandpaper. Take it easy—you won't be able to add material if you overdo.

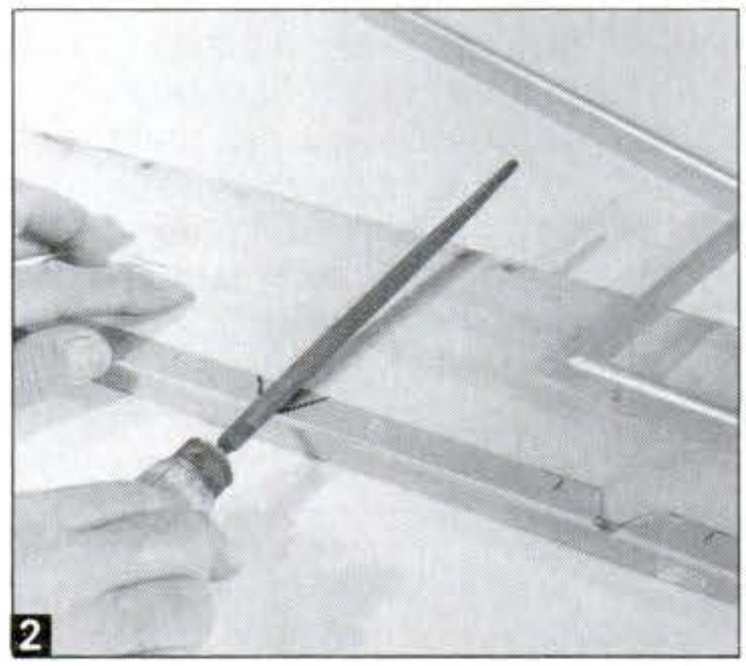
Don't cut the patches until you're ready to place them, but scale up the patch patterns and make a cardboard template for shaping the inset piece.

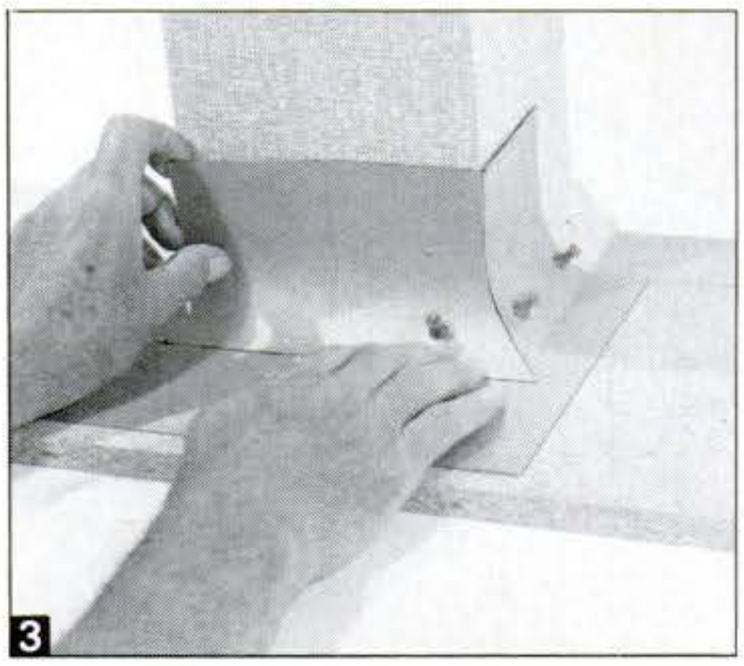
Keeping the material flexible is important—I let the covering sit in the sun for about 10 minutes before laying it. Then I rolled the material and placed it in the room, allowing it to adjust to room temperature for an hour. Next step: Unroll half the flooring and adjust it to fit against one wall; then unroll the second half. I used a heat gun (a hair dryer will do) for this procedure, especially at joint areas and where the material rolled up the wall.

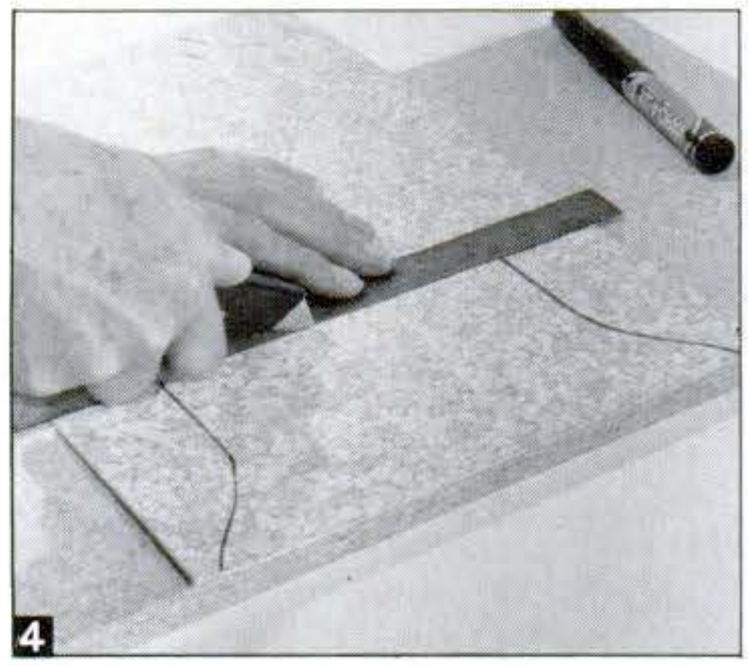
Now fold back half of the material and apply the recommended adhesive on that half of the floor, but don't spread it where the sheet vinyl goes up the wall. Repeat for the second half of the floor.

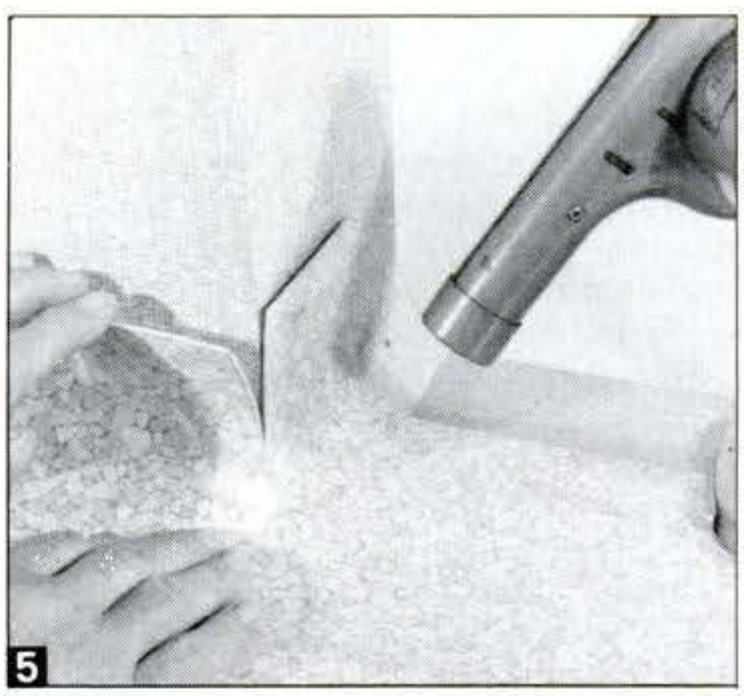
Once the flooring is laid, anchor the perimeter that laps up the wall. Apply adhesive to the back of these loose edges only. Press the flaps against the wall, then tap down the metal trim to secure them. At outside corners, test-fit the cardboard patch, then use the template as a cutting pattern. Trim the patch so joints butt tightly (see drawings), then use seam sealer to keep joint edges together and prevent dirt and moisture from entering. PS

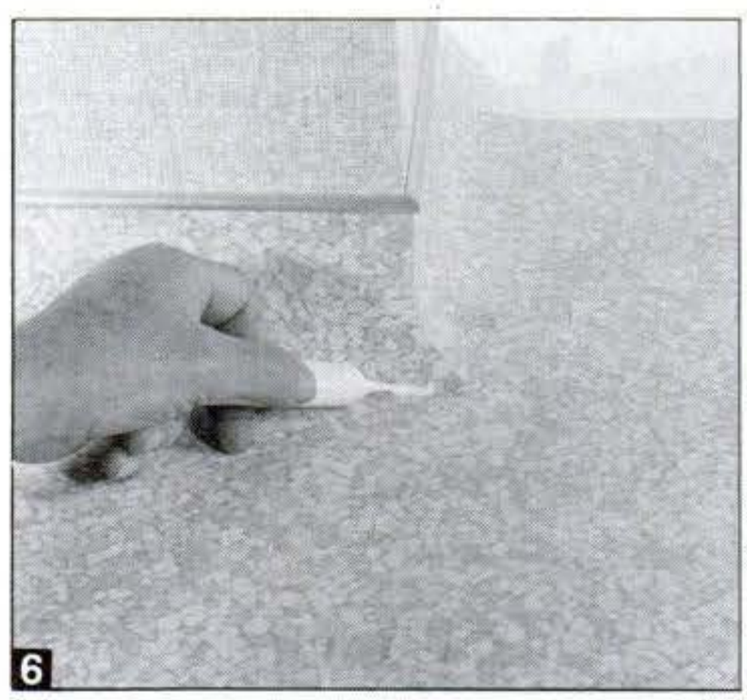












Wood cove molding nailed to the floor supports the vinyl flooring lapped atop it. Lip of the tap-down aluminum trim holds the cove in place (1). To miter the trim at outside corners, cut a notch in the flange, then file out a V-shape in the flat section (2). To fit flooring around a projecting wall, first test-fit cardboard templates (3), then cut a patch by gently scoring along a straightedge (4). Cut the curves, beveling edges for a smooth fit. Heat the flooring to make it flexible for fitting (5). Trim the patch, then apply adhesive to the molding and slip the patch in place. Seal the seams with sealer (6).

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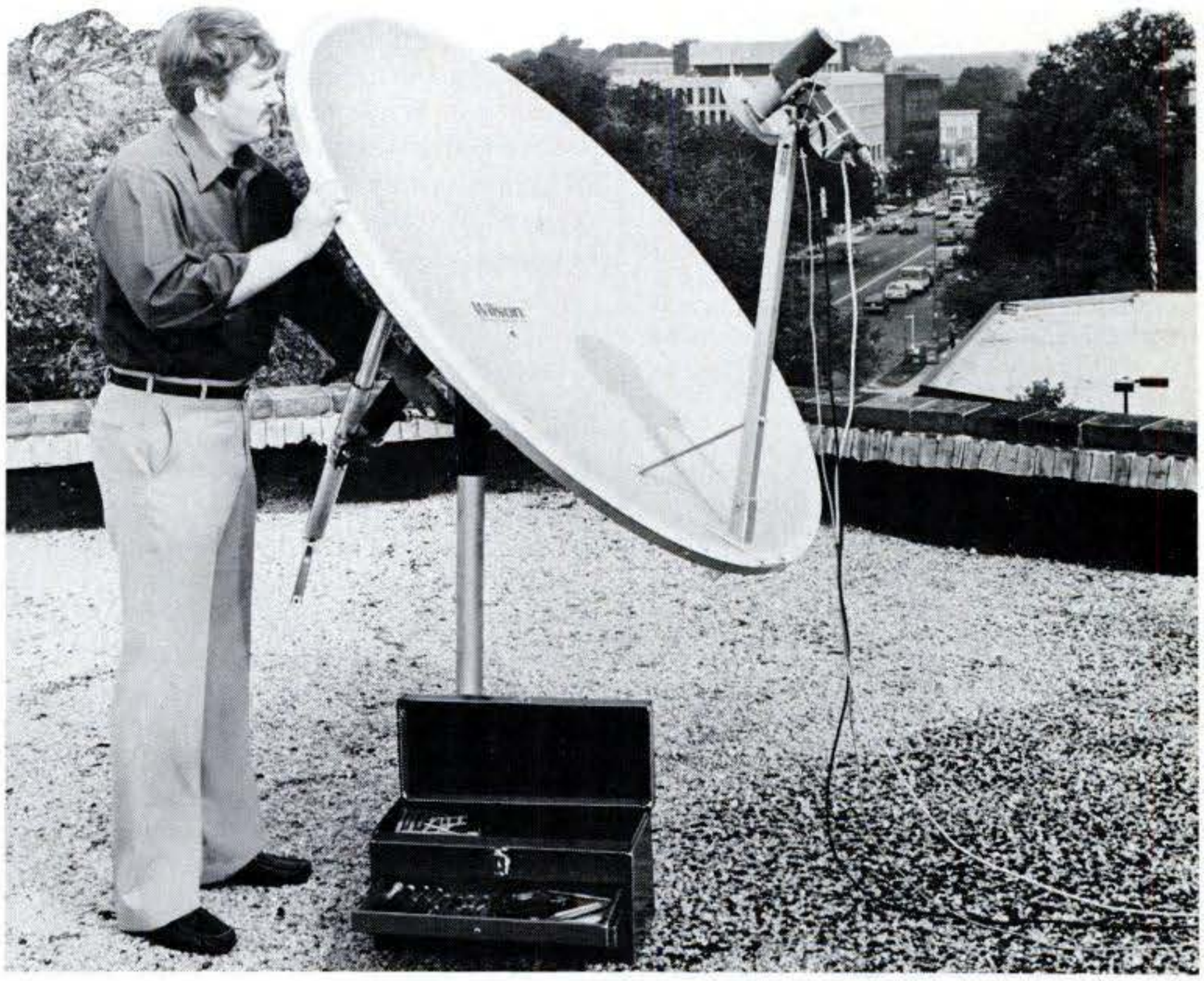

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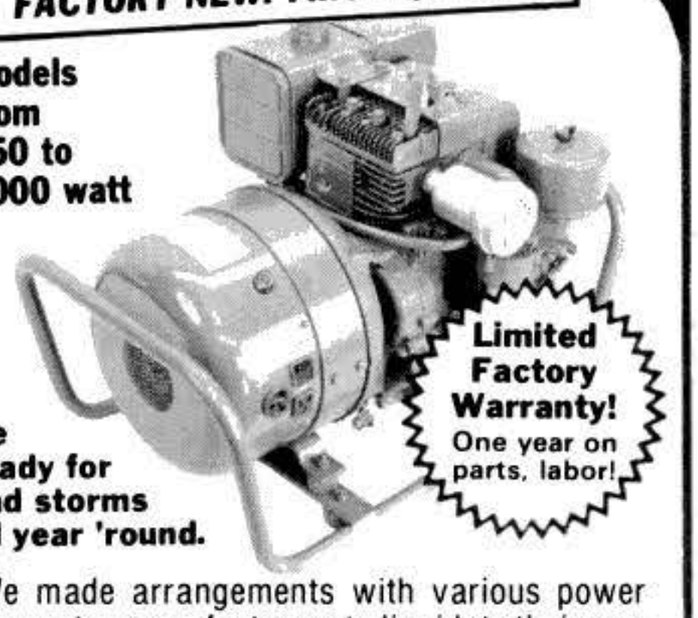

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Getting the lead out

I've read about the possibility of the federal government phasing out leaded gasoline. What about those cars that were built to run on leaded fuel; will their engines wind up on the scrap heap? Do these engines really need leaded fuel to run properly?

Paul Rohe, Las Cruces, N.M.

The biggest problem with using unleaded fuel in an engine designed for leaded fuel is short exhaust-valve life. Lead acts as a lubricant for exhaust valves and valve seats, so older engines have softer valves and seats than do newer engines designed to run on unleaded fuel. I'd suggest that you install premium hard exhaust valves and seats in your older engine. Unfortunately, in many of those engines there's no room for hard valves and seats. Of course, you could instead put in a top-cylinder oiler or put additives in your fuel, but both create way too much pollution. Granted, there are still a bunch of leaded-fuel cars out there, but the total probably is less than 10 to 15 percent of the car population, and the number gets smaller every day. Let's face it—emissions are a problem, and the solution isn't an easy one.

Fuel injection for trucks?

Ford and Chevrolet have been offering fuel-injection systems in their cars since 1982. Why haven't they used fuel injection in their trucks?

Mike Walls, Muscle Shoals, Ala.

Fuel injection, though a more precise way of metering fuel to an engine, is much more expensive than carburetion. The advantages of fuel injection—lower emissions, better mileage, and better driving feel—are not that critical for most trucks, and servicing injectors can be a chore. But I think that you'll begin to see fuel injection in trucks in the near future—with a higher price tag attached.

Tanks a lot

My 1980 Buick LeSabre with the 4.1-liter V6 engine has a rather unusual problem. It has difficulty accelerating under load when the fuel tank is less than one-quarter full. New fuel and air filters and a tuneup haven't helped. The car runs fine after a fuel fill-up and a few days of rest. I have never knowingly used gasohol, but I think that a load of fuel with an excessive level of alcohol may have aggravated the problem.

K. Linebrink, Middletown, Ohio

The fact that your car performs well with a full tank and not so well with a partial load sounds like the filter inside the tank is gummed up. Pull the tank, and check the filter for contamination. If it's OK, your problem may be improper fuel-tank ventilation; don't forget to look at the canister up in the front of the tank. As for alcohol, it isn't worth a damn for surface transportation. Any fuel that contains more than 10 percent alcohol can cause all kinds of problems for your engine in the long run; the alcohol in the fuel eats steel and aluminum like candy.

Wanted: granny gear

I have a 1983 ¾-ton GMC pickup with a 6.2-liter diesel engine. My truck desperately needs a stump-puller low gear. When hauling an eight-foot camper, it won't start moving if there's the slightest grade. It's equipped with a four-speed overdrive manual transmission with a 3.09-to-1 low-gear ratio. Is there a two-speed rear end or a transfer case I can install?

Richard Q. Danielson
Santa Maria, Calif.

You could install an M-20 four-speed transmission, which has a 6.55-to-1 ratio in low gear. But this would cost a lot, and the transmission could prove noisy. Add-on overdrive units seem to have disappeared; and they cost a lot to maintain. The real answer is that you've got the wrong truck for your needs. It would probably be cheaper, in the long run, to trade for a vehicle that's equipped to carry your camper.

Oil-and-fuel puzzler

I own a Pontiac Fiero with the 2.5-liter engine. The manual says that 5W-30 oil is the best weight for the widest temperature range. Some mechanics say, however, that using 5W-30 may

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damage my engine during prolonged driving or in hot weather. Should I use 5W-30, or go with 10W-40 or 20W-50 oil? Also, the car pings on 87-octane unleaded fuel. Premium leaded fuel —92-octane or higher—eliminates the ping for the most part. Will premium fuel damage my engine?

Louis A. Caputo, Clifton Park, N.Y.

I'd stick with the type and weight of oil specified in your owner's manual for your particular operating-temperature range. As for your question on fuel, using higher-octane unleaded won't hurt a bit; in fact, it may help your engine last longer.

Spark-plug nightmare

When I took my 1982 Chevrolet six-cylinder cargo van to the dealer to have the spark plugs changed, he told me that the air-conditioner compressor has to be removed and discharged before the front plug can be removed. Is there a special tool available to avoid this $65 operation? I can't imagine General Motors allowing such a design error.

Ross Sears, Lake City, Fla.

Just unhook the compressor from its bracket and wire it out of the way, leaving the lines connected. Now you can get at the front spark plug. Maybe now that car manufacturers are getting the emissions problem whipped, they can tell their engineers to design vehicles that are halfway possible to work on.

Too wound up

I have a 1983 GMC pickup truck with a 305-cubic-inch engine and a four-speed automatic transmission. In city driving the transmission stays in second gear all the way up to 35 mph —and to even higher speeds when it's cold. This makes driving around town expensive. The GMC dealer changed the transmission valve body, but the problem persists. Do you have any suggestions?

Arthur Pinke, Waterloo, Ont.

Chevy has a new valve body available at dealers that allows the transmission to shift from second to third gear at lower speeds. The part number is the same as the earlier one, but the new part has a very clear "X" cast into its back surface.

Got a car problem? Send it to "Say, Smokey—," POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. All letters are read, and those of widest interest are answered in this column. Due to the large volume of mail, Smokey cannot reply to letters not selected for publication.

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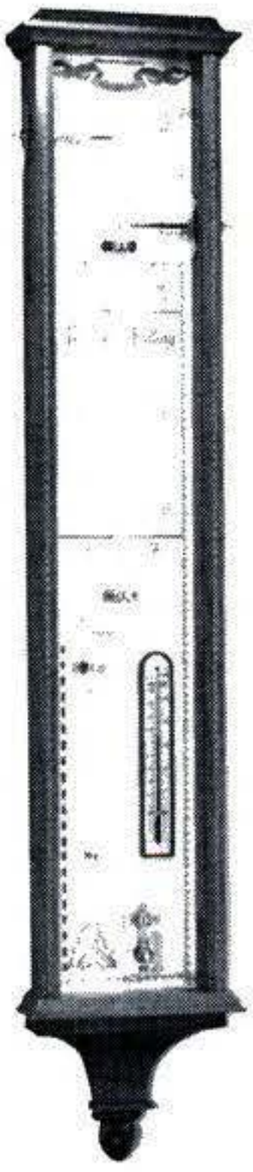

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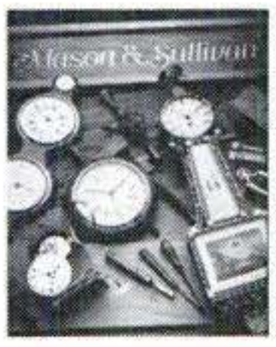

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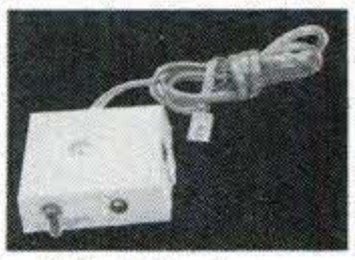

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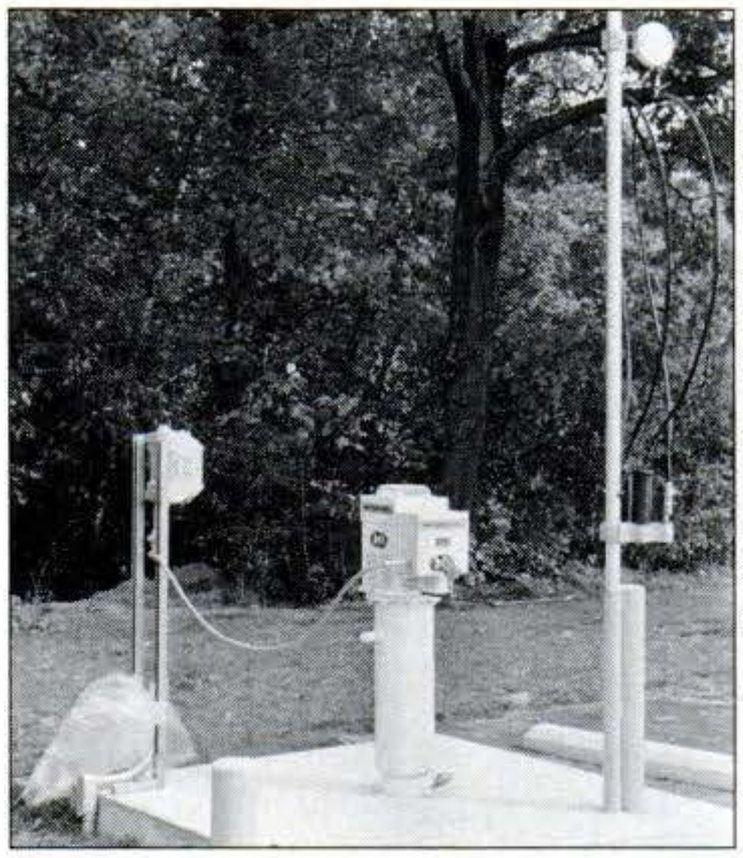
Shop Talk

By AL LEES

Running on natural gas

Doesn't look like a test lab, does it —that welcoming suburban home tucked into the woods outside Cleveland (bottom photo)? But it's on the grounds of the American Gas Assn. (AGA) Laboratories, a complex that does for gas-fired appliances what Underwriters' Laboratories does for electrical equipment.

Manufacturers of gas heaters and cooking units pay dues to have their units tested for safety, performance, and durability. The facility also undertakes original research—the pulse-combustion furnace you've read about in PS was developed here. The entire lab complex is energy self-sufficient. I toured the power plant that generates all the steam and electricity, powered (of course) by natural gas.



From the lab complex I headed for the house in the woods, where selected appliances are tried out under actual living conditions. Families are invited to move in for limited periods, and heating and cooling equipment is monitored via sophisticated meters, thermistors, and gauges (one measures emission concentrations). The house was shrewdly designed to be flexible. The amount of insulation and infiltration can be altered to change heating requirements. The home is tightly built with an unbroken vapor barrier and thorough weatherstripping. Air-exchange rates can be varied down to four percent per hour (20 to 50 percent is normal). After an hour in the house I fled to fresh air.

Outside, on its own slab, is a home filling station for the family car (upper photo). But instead of a gasoline pump, there's a metering valve for natural gas. It takes about eight hours to "fill up" one of the cars AGA has modified to run on either gas or gasoline. AGA claims that natural gas as auto fuel is about half the cost of gasoline and, because it burns cleaner, makes for fewer maintenance problems. But the dual-fuel cars have a range of only 100 miles. Dedicated vehicles (with no space-hogging gasoline tank) would have a greater capacity—and they're working to speed up that fill time.

Based on the lab's research, AGA offers free buyer's guides to gas appliances. There are separate booklets on water heaters, dryers, ranges, and furnaces. For copies, write AGA headquarters (AGA Public Information

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Tines so strong, they're guaranteed for life!

Mantis has a *Lifetime Warranty* on the tines (if they ever break, we'll replace them). A *Lifetime Replacement Agreement* on the engine. And a FREE *3-Week In-Your-Garden Trial that doesn't start until you start gardening.*

Free 3-Week In-Your-Garden Trial

Use a Mantis to start this year's garden for FREE! With our 3-Week In-Your-Garden Trial you can use a Mantis to till in old vegetation, fluff up the soil, and prepare new seed beds . . . for FREE! If you aren't totally delighted with it, we'll take it back and give you a full refund.

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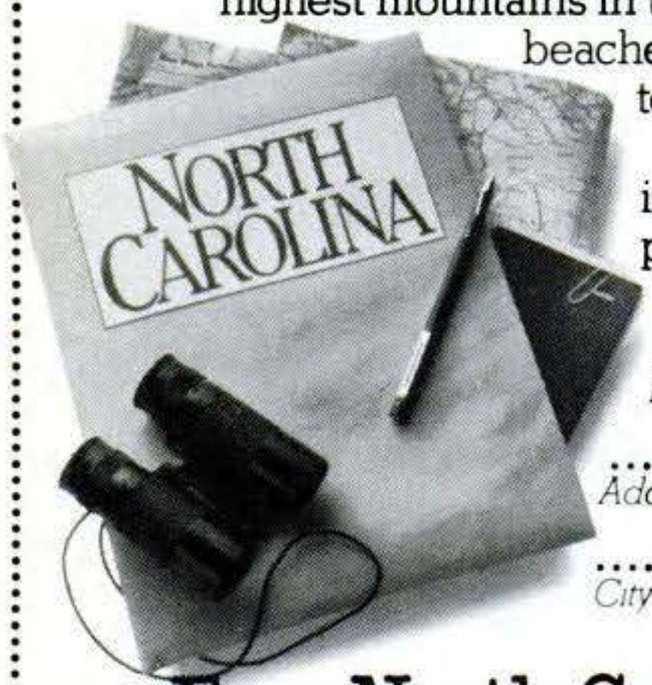

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Home tests for radon

Last November's feature on radon hazards mentioned a charcoal-based detector available from the Department of Physics at the University of Pittsburgh. I secured three of these $10 units to place in widely different houses, two of which are located in an area known for radon levels 10 times higher than the national average—the mountains of northeastern Pennsylvania.

One home was my own Lockbox—a pole house I built for a series of PS articles in the '70s. After a week's exposure the detector was resealed and mailed back to Pittsburgh for analysis. The average radon level for that period registered 0.7 picocurie per liter—below the average for U.S. homes (about 1 pCi/L). It's an especially low reading since the Lockbox was tightly closed and unoccupied all that week, with no ventilation. But the Lockbox hangs within its support poles, so at no point is any living area in contact with the earth.

The other test in this radon-high area was conducted in an underground home I'd visited and described in this column in March 1984. Even though this house is tucked into a mountain, I expected a low reading because the walls of earth-sheltered homes must be thoroughly waterproof, and membranes that seal against moisture also seal against radon. It was a surprise, then, that this home averaged (for the same period as my Lockbox test) a level of 22.8. When the concerned homeowner phoned the Pittsburgh lab, he was told that no home with readings under 25 was considered hazardous, but they recommended installing an air-to-air heat exchanger.

I mailed the third unit to southern California for exposure in a rammed-earth house, where one might expect the highest reading of all, since the walls *are* earth. The result of that week's monitoring? Lowest of all: 0.3. A possible explanation: The area is low in radon concentrations, and the test week was so warm that all windows were left open.

So although a one-week monitoring by such a device can be useful, there are so many variables (including local concentrations that can vary from week to week and season to season) that a longer monitoring by more sophisticated equipment is recommended. PS

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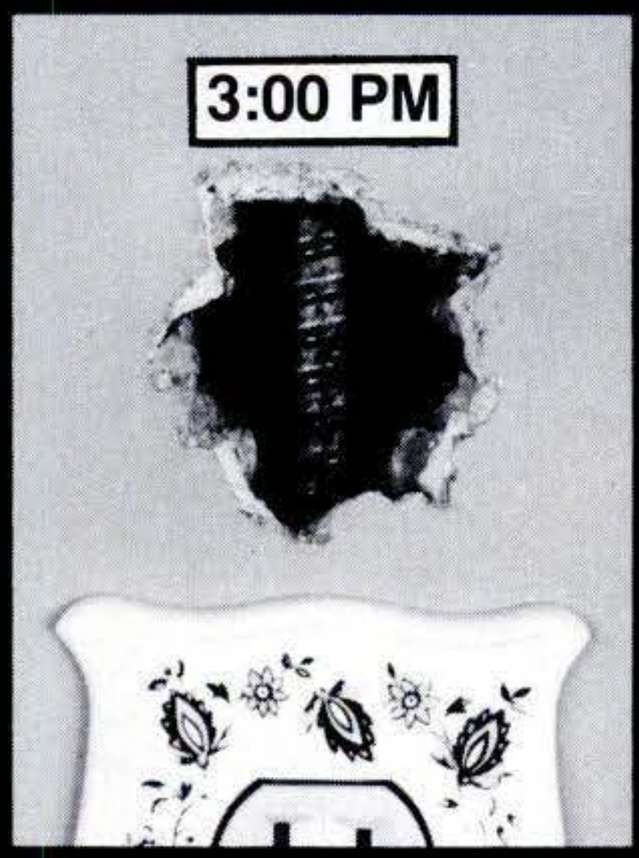

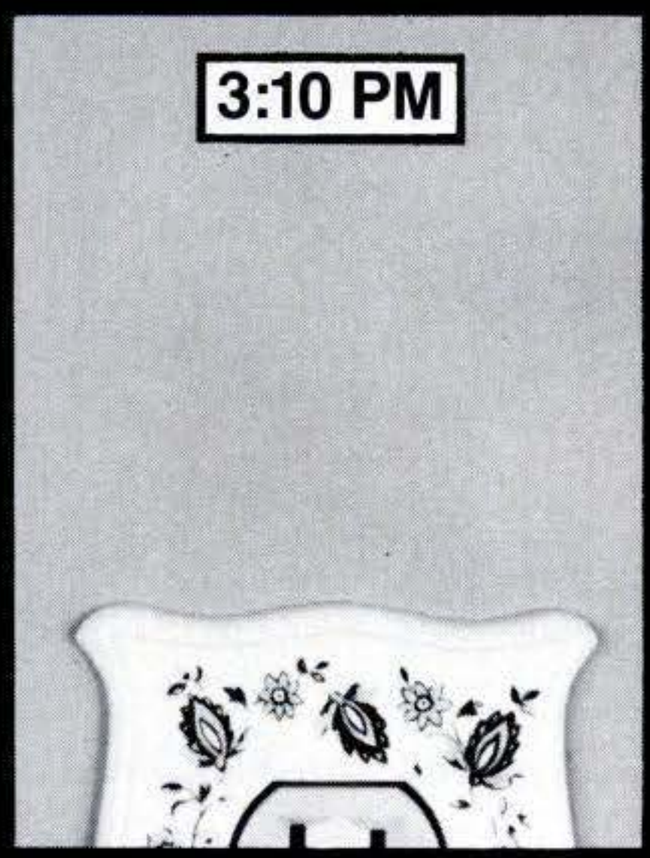

These unretouched photos show an actual demonstration of **WALL MATE** in use. A hole was punched in the dry wall in order to gain access to the electric box inside the wall. In **less than ten minutes** the hole was sealed and painted. As the unretouched photos shows, the hole is completely undetectable.

WALL MATE PROMISES...

- *Structural and Settling Cracks Never Come Back!*
- *Seams never Show!*
- *Stronger than Most Spackling Compounds!*
- *No Mess...Paint or Wallpaper Immediately!*
- *For Dry or Solid Plaster Walls!*

WALL MATE ENDS...

- *Spackling Forever!*
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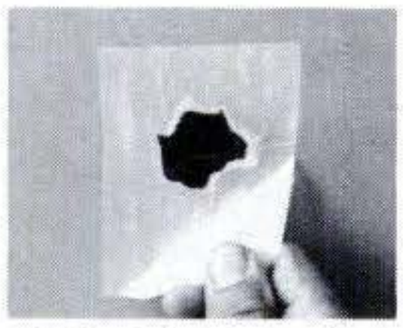
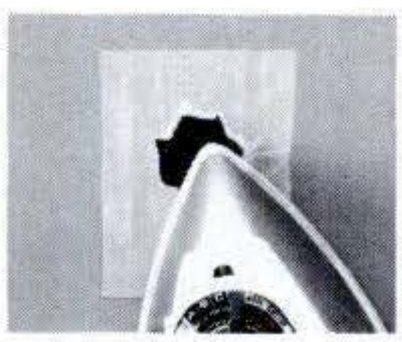
- *Drying Time Delays!*
- *Priming & Clean Up Mess!*
- *Buying Costly Additional Materials!*

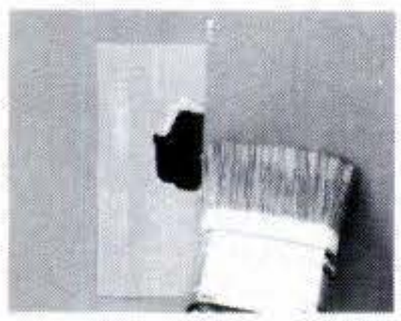
IT'S THIS EASY



APPLY—Self Adhesive WALL MATE covers damages instantly — no spackling or "plugging up" deep holes



IRON—Heat seal with hot iron to form smooth strong permanent bond to wall



PAINT—Paint or paper immediately—no waiting or drying time delays necessary

FASTER, SIMPLER, CLEANER AND SMOOTHER THAN ANY SPACKLING COMPOUND REPAIR!

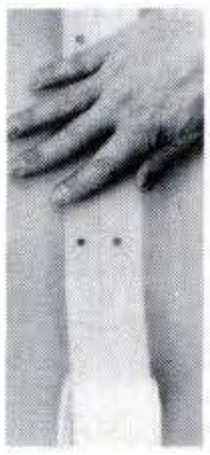
This amazing new patented polymer transparent film is so thin (only 3/1000th of an inch) that repairs are invisible when painted or wall papered.

WALL MATE may be cut with scissors, yet it's so strong (an offshot of aerospace technology) it's virtually impossible to puncture or tear with your finger! And once it's sealed to the wall with heat from an ordinary iron, it stays forever taut, even if the wall itself expands or contracts, meaning: **cracks or seams never show again!** It won't blister or bubble—adheres permanently to dry wall and plaster, even in corners where other wall tapes may wrinkle, WALL MATE irons flat and neat.

WALL MATE REPAIRS CRACKS, HOLES AND DENTS FOREVER!

How often has that wall crack above the door frame opened up again after you spent hours spackling, sanding and repainting? Has a door knob banged against the wall leaving an ugly dent or hole . . . or your kids bike slammed into the wall gouging it? How about those gaping holes left by toggle bolts, mollys and picture hooks? **Now you can fix this in just minutes with WALL MATE.**

AMAZING WALL MATE EVEN JOINS DRY WALLS WITHOUT SPACKLING!



Think what you once went through joining dry wall boards to make walls and ceilings . . . all the time you spent spackling, taping, sanding, priming and waiting for each stage to dry. **Now you just apply WALL MATE and it's ready to paint or wall paper immediately—it doesn't even need a prime coat! You can do the whole job in hours, not days!**

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Popular Science leisure home

Media-center retreat

By AL LEES
Architects: Samuel and David Paul

To keep this long-running series fresh and timely, I often toss a challenge to one of the architects from whom POPULAR SCIENCE commissions leisure homes. Over lunch last spring, I remarked to Samuel Paul that because leisure homes are usually in remote areas, they're often beyond cable-TV hookups and access to neighborhood cinemas.

"But Al," Sam responded, "don't you find that adult guests at your weekend retreat *welcome* being away from all that? Aren't they grateful for undistracted conversation, or a good book they can curl up with?"

"Some are," I admitted, "but some get a little wistful about leaving the electronic wonders behind. And one eleven-year-old daughter of a guest announced firmly that she was sacrificing her favorite TV shows to visit me."

As we discussed the subject, the idea behind this month's house took shape. At its core (inset) is a comfortable media center with projection TV and all the stereo gear you'd need for concerts on a disc or tape. Riding out of sight on the roof is a small dish antenna aimed at a chosen satellite in the southern sky. A properly sited roof perch is ensured by facing the glass wall south for solar gain. (Country homes must face south to take advantage of

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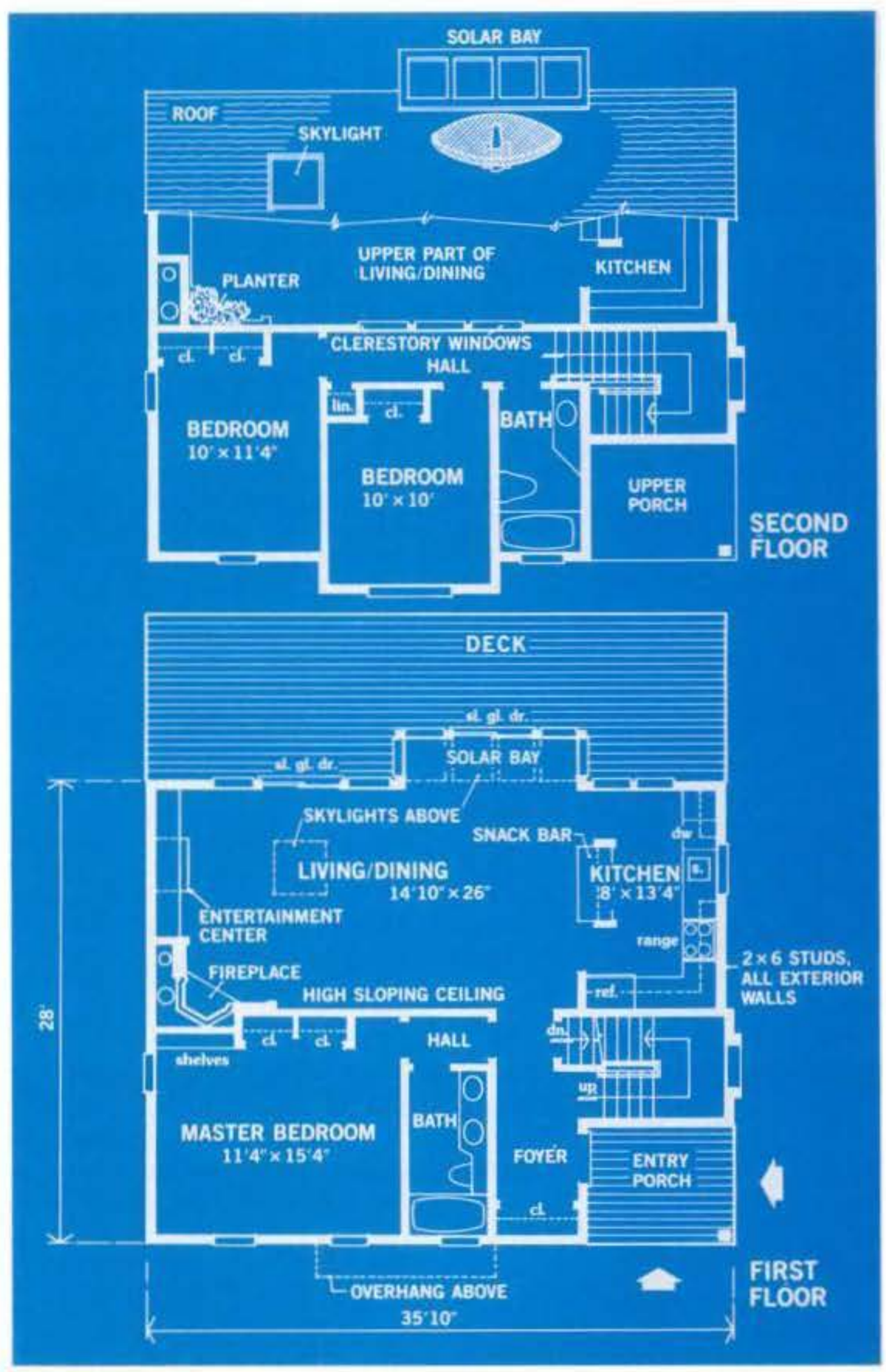

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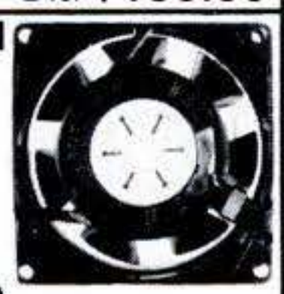

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Low noise level. Can be mounted for cooling or exhaust.
Dim.: 3⅛" sq. x 1½" deep
12VDC — Papst #8312
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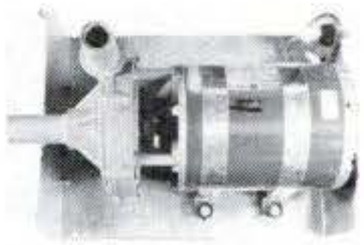

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(Less printer & w/o cabinet)

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Contains 11 C cells. For model boats, toys, etc.
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For use with model cars, trains, boats, planes, etc. . . .

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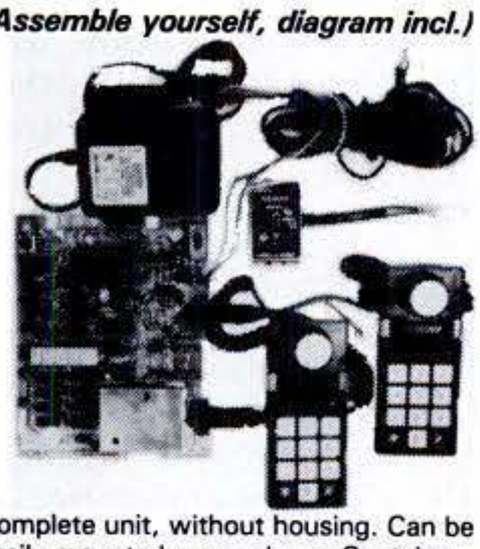
COLECO VISION KIT
(Assemble yourself, diagram incl.)



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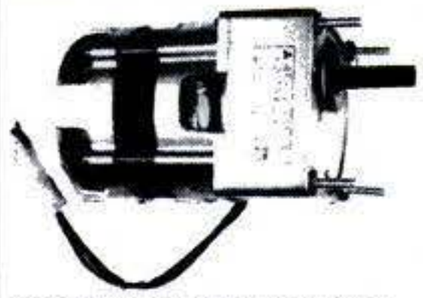
Mfr — GE 5KH47KR310
Item #5315 **$29.95** New

55 RPM SATELLITE POSITIONING MOTOR



Reversible capacitor induction motor. 115V/60 Hz., 30 in./lb. torque. 14W. Front flange mount
OA Dim.: 3¼"D x 5"L.
Shaft: ⅜"D x 1"L.
Mfr — Matsushita or equiv.
Item #5149 **$9.95** RFE

1/4 HP, 14,000 RPM MOTOR w/Speed Control

115VAC/60 Hz. CW rotation, tool & appliance duty. Ideal for use in high-speed drills. With speed control, can be used at variable speeds for mixing paints, etc. Shaft: 5/16" dia. x 1¼"L
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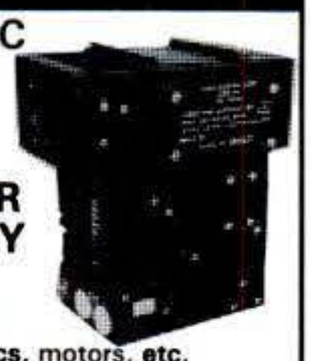

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Size: 4" x 8½" x 7¾".
Mfr — Acme PS59134
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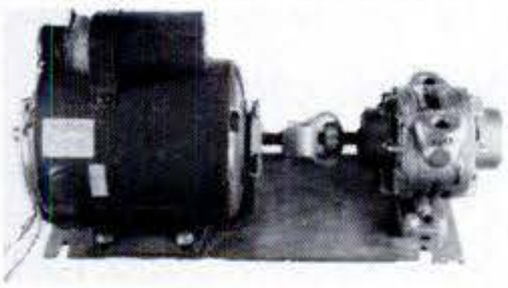
ROTARY VANE VACUUM PUMP & MOTOR



Usable for vacuum or pressure application. 4 CFM/15 PSI max. 15" continuous. 28" intermittent. Pump is directly coupled to a GE 1/3 HP, 1625 RPM, 115 VaC, 50/60 Hz., single phase 3.8A motor. Thermally protected. Assembly is mounted on a metal base.
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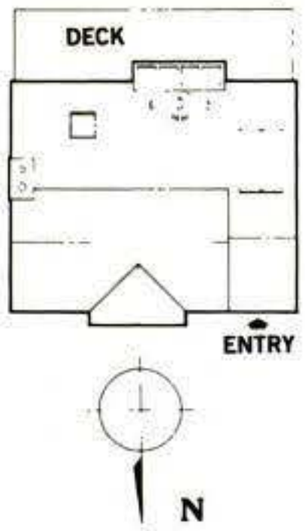
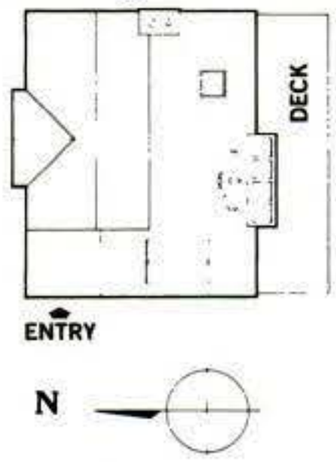


STREET TO NORTH



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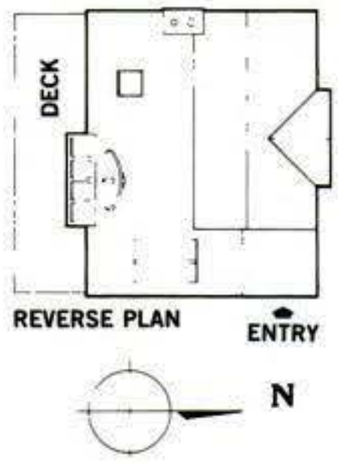
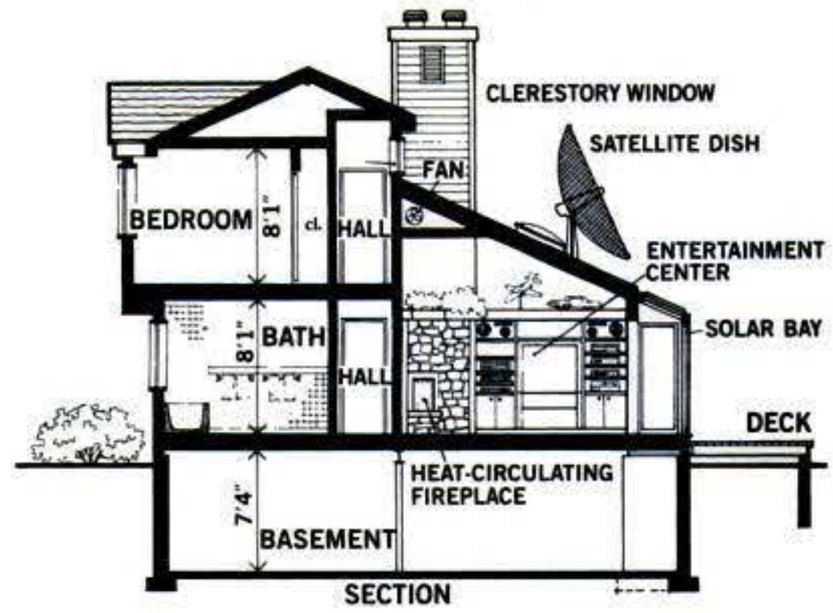


STREET TO EAST



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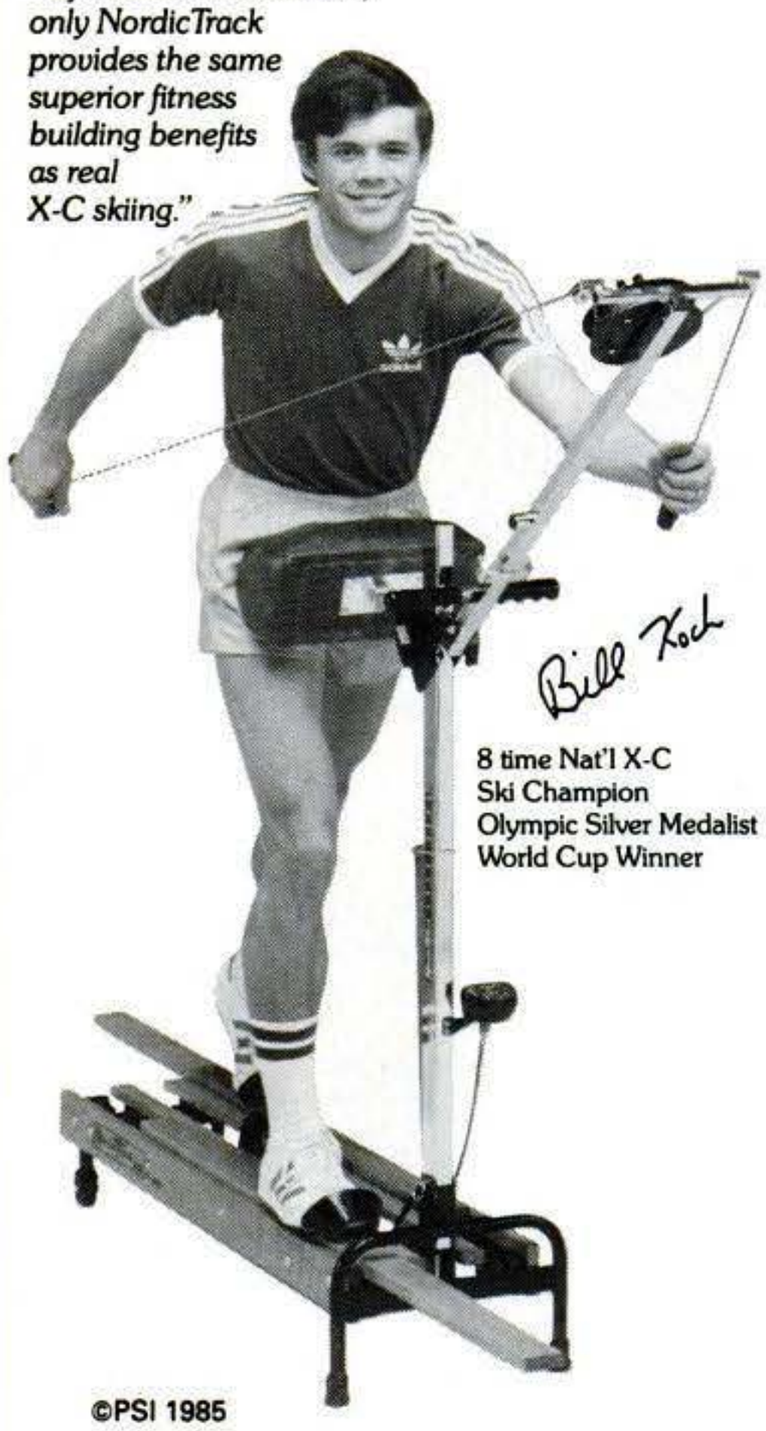

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all good things, these days.) Note from the inset that the floor of the sunspace is paved with masonry to soak up solar heat. The heat will radiate into the living area on cool evenings. In midsummer, if the glazing isn't naturally shaded, you'll probably want insulating blinds here.

Cabinets built into the entertainment wall will store a slide projector and VCR tapes, making this a versatile area for evening or rainy-day entertaining—rendered even cozier by a crackling fire in the heat-circulating unit angled across one corner. The valance shelf above the speakers contains a pull-down screen. This entertainment wall is the core of the house, placed so its screens will be in full view of the living, dining, and kitchen areas, which flow together into one large space with the solar bay.

The siting sketches at upper right show how the house can be turned in relation to the road so the glass wall and dish antenna will always face south. The two-story entry porch (not seen in the color rendering) can be oriented in either of two directions, as indicated by the arrows. The third orientation requires ordering a mirror-reverse plan (see below).

The entry foyer leads back to the living areas, as well as to the master bedroom off the bathroom hall. The bath, accessible to guests, features a double vanity. Also off the foyer is a well-lighted stairway to the second floor. The hall to the upstairs bedrooms is also well-lighted, thanks to clerestory windows. A bubble skylight floods the media center with daylight. The other roof-mounted glazing seen in the rendering is a solar collector for domestic hot water. PS

How to order your plans

One set of blueprints for the media-center retreat (Pinewood) is $100; five sets (for construction, financing, and obtaining permits) are $150. An additional mirror-reverse print costs $15; a materials list is $25. Address orders or queries to Homes for Living Inc., 107-40 Queens Blvd., Forest Hills, N.Y. 11375. Add $5 to all orders to cover postage and handling, and allow four weeks from time order is mailed for delivery.

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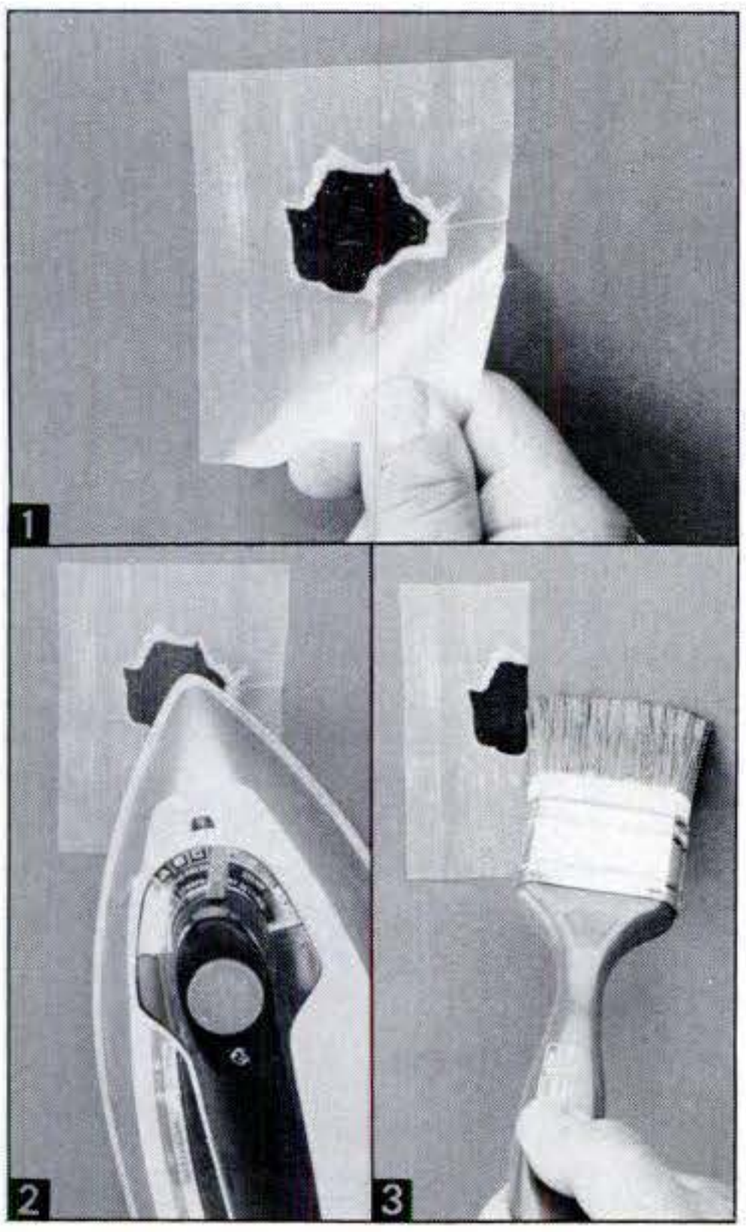
Iron-on wall patch

"Ends spackling forever!" claims the Wall Mate package. "... cracks never come back!" Wall Mate is a new tape for repairing wallboard or plaster walls. It also can be used for wallboard installation.

"Cracks don't come back," says Wall Mate's inventor, André Bernard, president of Meric Industries (Box 276, Mt. Kisco, N.Y. 10549), "because the tape is a nylon-type polymer that has tremendous give but always pulls back to its original form." Wall Mate ends spackling because you can put it over voids without filling them first, and then paint or paper directly over the ultra-thin (3/1,000-inch) tape.

But the biggest surprise is the way you apply Wall Mate: You iron it on. "The tape is impregnated with a new type of heat-activated adhesive," says Bernard. It melts at about 270 degrees F, the permanent-press setting on your household iron. To make a repair you just cut the tape to size, peel off the paper backing, and apply the tape to the wall (photo 1). A pressure-sensitive adhesive holds the tape in place while you iron it (photo 2). You can paint or paper over it immediately (photo 3). "If a wrinkle should ever appear, the heat from a hair dryer will shrink the tape back to shape," Bernard advises.

Wall Mate is available in home-center and paint stores in various sizes. A package that includes a 2½-inch-by-eight-foot roll and two 4½-by-six-inch patches costs about $7.—*V. Elaine Gilmore*



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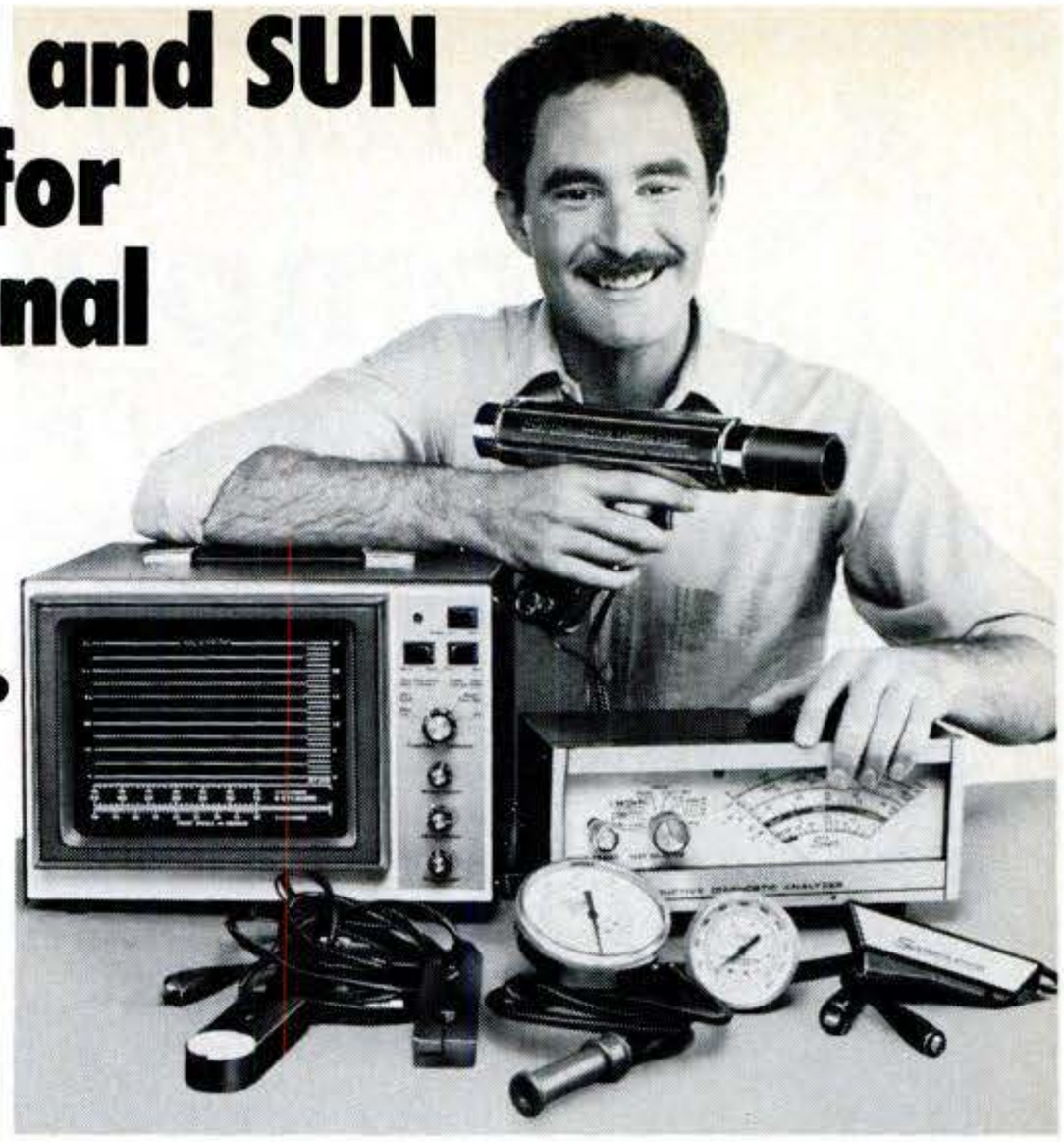

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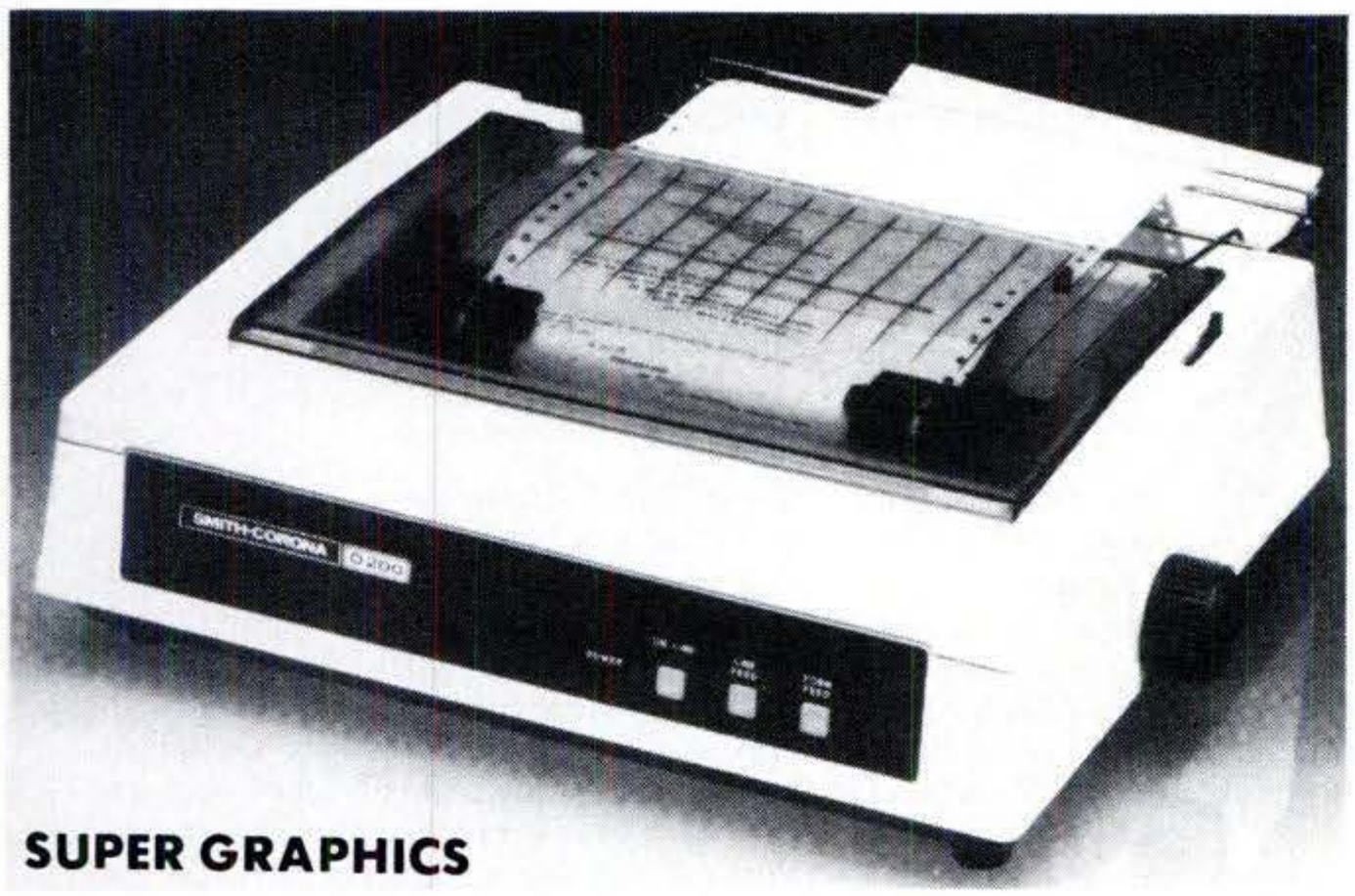

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Last chance to enter the tenth annual PS/APA

panel-project contest

By AL LEES

March 3 is the deadline for entering the 10th anniversary competition cosponsored by POPULAR SCIENCE and the American Plywood Assn. Read the rules below, build your project (or an accurate scale model), send a photo of it along with the entry coupon, and you're in line for fame as well as fortune: PS publishes all winning entries (see the portfolio of 1985 winners in last August's issue), and APA offers plans.

Assembly instructions for last year's nine projects were published in a colorful booklet (being examined by the woman at left); it's still available for $5 from the address in the coupon. Complete plans for winners from the first eight years of the contest are available in a hard-cover book entitled *67 Prizewinning Plywood Projects*. For your copy, send $27.95 plus $2.39 for shipping to Popular Science Books, Dept. APA, Box 2018, Latham, N.Y. 12111.

This year's cash awards total $5,250 —including a top prize of $1,250 in each of three categories. You can build your projects out of any structural panel: plywood, waferboard, particleboard, or a combination of several. Your snapshot needn't be publishable, but a photo must accompany your entry. Good luck! PS

• **PRIZES:** A $1,250 check will go to the top entrant in each of three major categories. There will be a secondary award of $500 in each category for a total of $1,500 additional. An honorable-mention entry in each category will receive a generous selection of how-to books from the Popular Science Book Division.

• **HOW TO QUALIFY:** Your project must be constructed from a stated amount of an APA-trademarked panel appropriate for the intended use—plywood, waferboard, particleboard, or any combination. Projects should be designed for efficient layout of the panel or panels you select; parts should be scaled, arranged, and nested to minimize waste. You may enter your project in any of the three categories, specifying which thickness you choose for your half (four-by-four- or two-by-eight-foot) or full (four-by-eight-foot) panels. Should you choose to enter the multiple-panel category, you may use two or more different thicknesses, if that makes sense structurally.

In all categories, aim for minimal waste and minimal use of additional materials; non-panel purchases must not exceed $100, and the structural panel you choose should remain the dominant material. Functional, structurally sound designs are sought in this contest, but decorative or ingenious projects will also qualify if they represent an efficient use of the panel or panels you specify and if they can be built with home-workshop tools.

• **HOW TO ENTER:** Fill out our entry coupon, or list all information the coupon calls for on a separate sheet of paper —including a rough sketch of the APA grade trademark(s) stamped on the back face or edge of each panel you choose. Mail this with at least one clear photograph (black-and-white or color print preferred, but color slide is acceptable) plus a dimensioned diagram of how the project parts were laid out on the panel or panels. A crude pencil sketch will suffice if it's thoroughly labeled with critical dimensions. If you prefer, you may construct and photograph an accurate scale model of your project, but a photograph must accompany each entry. Don't submit models, full-size cutting patterns, or plans sheets larger than 18 by 24 inches. Also include a list of all materials used: grade and thickness of your panel(s) plus any lumber, hardware, and finishing materials (paint, stain, plastic laminate). Also jot down special construction tips you'd like to pass on to anyone attempting to duplicate your project. If no publishable photo exists, POPULAR SCIENCE and APA reserve the right to arrange photography at your convenience (and their expense). Entries must be delivered to the Tacoma post office box by March 3, 1986; upon delivery, publication rights belong exclusively to APA and POPULAR SCIENCE unless neither exercises the option within six months of receipt.

Print the category you're entering (½ PANEL, SINGLE PANEL, 1½ TO 6 PANELS) in the lower left corner of your envelope (one entry per envelope, please). No entries can be acknowledged, and none will be returned unless accompanied by a written request and a self-addressed envelope with proper postage.

• **JUDGING** (by PS Reader Activities Editor Al Lees and representatives of APA) will be for the most efficient and appropriate use of the panel or panels you choose. Plans for all nine winning projects will be available from APA after Sept. 1. Winners will be notified by April 15; winning entries will be shown in the August issue of POPULAR SCIENCE.

ENTRY COUPON (Clip and attach to your plans sketch)

Mail entry to:
POPULAR SCIENCE CONTEST
Box 11700, Tacoma, Wash. 98411

To qualify, entry must reach Tacoma address by March 3, 1986

YOUR NAME (print or type) _____

ADDRESS _____ Daytime Phone No. _____

CITY _____ STATE _____ ZIP _____

Copy the panel's grade stamp here

Description of project _____

Which category? ☐ ½ PANEL ☐ SINGLE PANEL ☐ 1½ to 6 PANELS

What panel and in what thickness? _____

My signature certifies that this project is of my own design.

Sign here _____

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My name is John Wright. Not too long ago I was flat broke. I was $31,000 in debt. The bank repossessed my car because I couldn't keep up with the payments. And one day the landlord gave me an eviction notice because I hadn't paid the rent for three months. So we had to move out. My family and I stayed at my cousin's place for the rest of that month before I could manage to get another apartment. That was very embarrassing.

Things have changed now. I own four homes in Southern California. The one I'm living in now in Beverly Hills is worth more than one million dollars. I own several cars, among them a brand new Mercedes and a brand new Cadillac. Right now, I have a $1 million dollar line of credit with the banks and have certificates of deposit at $100,000 each in my bank in Beverly Hills.

Best of all, I have time to have fun. To be me. To do what I want. I work about 4 hours a day, the rest of the day, I do things that pleases me. Some days I go swimming and sailing — shopping. Other days, I play racquetball or tennis. Sometimes, frankly, I just lie out under the sun with a good book. I love to take long vacations. I just got back from a two week vacation from — Maui, Hawaii.

I'm not really trying to impress you with my wealth. All I'm trying to do here is to prove to you that if it wasn't because of that money secret I was lucky enough to find that day, I still would have been poor or may be even bankrupt. It was only through this amazing money secret that I could pull myself out of debt and become wealthy. Who knows what would have happened to my family and me.

Knowing about this secret changed my life completely. It brought me wealth, happiness, and most important of all — peace of mind. This secret will change your life, too! It will give you everything you need and will solve all your money problems. Of course you don't have to take my word for it. You can try it for yourself. To see that you try this secret, I'm willing to give you $20.00 in cash. (I'm giving my address at the bottom of this page.) I figure, if I spend $20.00, I get your attention. And you will prove it to yourself this amazing money secret will work for you, too!

Why, you may ask, am I willing to share this secret with you? To make money? Hardly. First, I already have all the money and possessions I'll ever need. Second, my secret does not involve any sort of competition whatsoever. Third, nothing is more satisfying to me than sharing my secret only with those who realize a golden opportunity and get on it quickly.

This secret is incredibly simple. Anyone can use it. You can get started with practically no money at all and the risk is almost zero. You don't need special training or even a high school education. It doesn't matter how young or old you are and it will work for you at home or even while you are on vacation.

Let me tell you more about this fascinating money making secret:

With this secret the money can roll in fast. In some cases you may be able to cash in literally overnight. If you can follow simple instructions you can get started in a single afternoon and it is possible to have spendable money in your hands the very next morning. In fact, this just might be the fastest *legal* way to make money that has ever been invented!

This is a very safe way to get extra cash. It is practically risk free. It is not a dangerous gamble. Everything you do has already been tested and you can get started for less money than most people spend for a night on the town.

One of the nicest things about this whole idea is that you can do it at home in your spare time. You don't need equipment or an office. It doesn't matter where you live either. You can use this secret to make money if you live in a big city or on a farm or anywhere in between. A husband and wife team from New York used my secret, worked at home in their spare time, and made $45,000 *in one year.*

This secret is simple. It would be hard to make a mistake if you tried. You don't need a college degree or even a high school education. All you need is a little common sense and the ability to follow simple, easy, step-by-step instructions. I personally know a man from New England who used this secret and made $2 million *in just 3 years.*

You can use this secret to make money no matter how old or how young you may be. There is no physical labor involved and everything is so easy it can be done whether you're a teenager or 90 years old. I know one woman who is over 65 and *is making all the money she needs* with this secret.

Here's what newspapers and magazines are saying about this incredible secret:

The Washington Times:
The Royal Road to Riches is paved with golden tips.

Los Angeles Herald Examiner:
We've all got to start somewhere... *The Royal Road to Riches* is the first step in the right direction!

National Examiner:
John Wright has an excellent guide for achieving wealth in your spare time.

Income Opportunities:
The Royal Road to Riches is an invaluable guide for finding success in your own back yard.

News Tribune:
Wright's material is a MUST for anyone who contemplates making it as an independent entrepreneur.

Success!
John Wright believes in success, pure and simple.

Money Making Opportunities:
John Wright has a rare gift for helping people with no experience make lots of money. He's made many people wealthy.

Hollywood Trade Press:
We have never heard of an advertiser offering to pay readers $20 to try its program. Wright's willingness to do this convinces us that his money secret must really work.

California Political Week:
...The politics of high finance made easy.

Hollywood Citizen News:
He does more than give general ideas. He gives people a detailed A to Z plan to make big money.

The Desert Sun:
Wright's *Royal Road to Riches* lives up to its title in offering an uncomplicated path to financial success.

When you use this secret to make money you never have to try to convince anybody of anything. This has nothing to do with door-to-door selling, telephone solicitation, real estate or anything else that involves personal contact.

Everything about this idea is perfectly legal and honest. You will be proud of what you are doing and you will be providing a very valuable service.

It will only take you two hours to learn how to use this secret. After that everything is almost automatic. After you get started you can probably do everything that is necessary in three hours per week.

PROOF

I know you are skeptical. That simply shows your good business sense. Well, here is proof from people who have put this amazing secret into use and have gotten all the money they ever desired. Their initials have been used in order to protect their privacy, but I have full information and the actual proof of their success in my files.

'More Money Than I Ever Dreamed'

"All I can say — your plan is *great!* In just 8 weeks, I took in over $100,000. More money than I ever dreamed of making. At this rate, I honestly believe, I can make over a million dollars per year."

A. F., Cranston, R.I.

'$9,800 In 24 Hours!'

"I didn't believe it when you said the secret could produce money the *next morning.* Boy, was I wrong, and you were right! I purchased your *Royal Road to Riches.* On the basis of your advice, $9,800 poured in, in less than 24 hours! John, your secret is incredible!"

J. K., Laguna Hills, CA

'Made $15,000 In 2 Months At 22'

"I was able to earn over $15,000 with your plan — in just the past two months. As a 22 year old girl, I never thought that I'd ever be able to make as much money, as fast as I've been able to do. I really do wish to thank you, with all of my heart."

Ms. E. L., Los Angeles, CA

'Made $126,000 In 3 Months'

"For years, I passed up all the plans that promised to make me rich. Probably I am lucky I did — but I am even more lucky that I took the time to send for your material. It changed my whole life. Thanks to you, I made $126,000 in 3 months."

S. W., Plainfield, IN

'Made $203,000 In 8 Months'

"I never believed those success stories... never believed I would be one of them... using your techniques, in just 8 months, I made over $203,000... made over $20,000 more in the last 22 days! Not just well prepared, but simple, easy, fast... John, thank you for your *Royal Road to Riches!*"

C. M., Los Angeles, CA

'$500,000 In Six Months'

"I'm amazed at my success! By using your secret I made $500,000 in six months. That's more than twenty times what I've made in any single year before! I've never made so much money in such short time with minimum effort. My whole life I was waiting for this amazing miracle! Thank you, John Wright."

R. S., Mclean, VI

As you can tell by now I have come across something pretty good. I believe I have discovered the sweetest little money-making secret you could ever imagine. Remember — I guarantee it.

Most of the time, it takes big money to make money. This is an exception. With this secret you can start in your spare time with almost nothing. But of course, you don't have to start small or stay small. You can go as fast and as far as you wish. The size of your profits is totally up to you. I can't guarantee how much you will make with this secret but I can tell you this — so far this amazing money producing secret makes the profits from most other ideas look like peanuts!

Now at last, I've completely explained this remarkable secret in a special money making plan. I call it "The Royal Road to Riches". Some call it a miracle. You'll probably call it "The Secret of Riches". You will learn everything you need to know step-by-step. So you too can put this amazing money making secret to work for you and make all the money you need.

To prove this secret will solve all your money problems, don't send me any money, *instead postdate* your check for a month and a half from today. I guarantee not to deposit it for 45 days. I won't cash your check for 45 days before I know for sure that you are completely satisfied with my material.

$20.00 FREE!

There is no way you can lose. You either solve all your money problems with this secret (in just 30 days) or you get your money back *plus* $20.00 *in cash* **FREE!**

Do you realize what this means? You can put my simple secret into use. Be able to solve all your money problems. And if for any reason whatsoever you are not 100% satisfied after using the secret for 30 days, you may return my material. And then I will not only return your original UNCASHED CHECK, but I will also send you an *extra $20.00 cashiers check* just for giving the secret an honest try according to the simple instructions.

I GUARANTEE IT! I have given references, therefore, there is absolutely NO RISK ON YOUR PART.

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SWORN STATEMENT:

"As Mr. John Wright's accountant, I certify that his assets exceed one million dollars."

Mark Davis
Beverly Hills, CA

REFERENCE:

We belong to the Santa Monica Chamber of Commerce. Their address is: 1460 Fourth Street, Santa Monica, CA 90401.

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Future truck

There's going to be a lot less to distinguish the tractor from the trailer in the tractor-trailer truck of the 1990s. Gone will be the huge, air-stream-clogging gap behind the cab of today's heavy-duty hauler. In its place will be a flexible seal that'll help form a single, continuous surface all the way to the rear. In addition, a raised cab roof will direct the air up and away from the trailer, while flush surface fairings will deflect the impeding air away from wheel wells and other openings. Even the cab steps will automatically retract out of the airflow when not in use.

That's going to be the shape of future trucks, at least as it's envisioned by Mitsubishi Motor Corp. engineers, who have placed all these features plus a few more in the MT-90X concept truck (above), which was displayed at the recent Tokyo Motor Show.

The point of the smoother look, say Mitsubishi engineers, is to improve the fuel economy of large trucks by sculpting them to slice more cleanly through the air. And the results look promising. The MT-90X has a drag coefficient of 0.38—impressively small numbers for a big truck.

But that's not all that can be done to improve fuel mileage, they say. For instance, all the wheels on the MT-90X have been fitted with *single* (rather than multiple) tires to reduce rolling resistance and weight. Wide, low-profile tubeless radials make this possible.

Improved fuel consumption is also the goal of a new "mechanical/automatic transmission" system, which is said to provide better fuel consumption than conventional torque-converter automatics. Fed with data on load as well as vehicle and engine speed, a computer automatically selects the correct gear from the MT-90X's seven-speed clutchless gearbox. A lightweight front suspension built from glass-fiber-reinforced plastic also improves fuel mileage.

Increased fuel economy and bottom-end torque is obtained from the truck's electronically managed Big 11 Turbo engine through the use of a valve that optimizes the fuel mixture's swirl (according to speed and load) as it enters each cylinder. The fuel-injection pressure and timing are also optimized for similar benefits.—*Steven Ashley*

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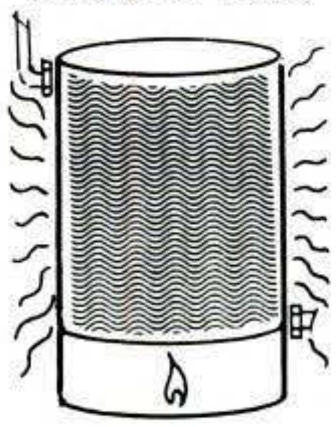	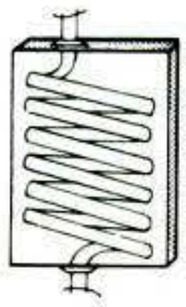
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 [Continued from page 74]

ways rich and bold), the color ribbons don't last long. For instance, an all-black ribbon for printing text with the Okimate 20 lasts for 75 pages; a color ribbon for printing pictures lasts less than 15.

Print speeds of 60 to 80 characters per second (cps) aren't unusual with even the low-cost thermal-transfer printers. Usually, but not always, the slower the speed, the better the print quality. "When the print head moves slower," explains Ewin, "there is more time to melt the ribbon's ink onto the paper, so print quality is improved."

A new wrinkle in thermal-transfer technology, called resistive transfer, comes from IBM. Instead of passing heat through a ribbon, the IBM Quietwriter passes minute pulses of electricity. A special layer in the all-black Quietwriter ribbon reacts to the electrical charges and turns the voltage spikes into heat, depositing ink dots at just the right places.

The thimble-sized print head inside the Quietwriter contains 40 heat-producing elements, enabling it to achieve a resolution exceeding 350 dots per inch. Text from the Quietwriter looks almost indistinguishable from that made by a typewriter. And the newest model, the Quietwriter II, also prints dot-addressable graphics.

Ink-jet

Ink-jet printers shoot tiny droplets of ink directly onto the paper to paint words and pictures. The print head has one or more channels with a nozzle that sprays onto the page.

Most new ink-jet printers operate on the *drop-on-demand* principle: A drop of ink is pushed out of the nozzle when a dot is needed on a page. The older and more expensive continuous-flow method uses a complex magnetic deflection system in which a nonstop ink flow is either sprayed onto the page or diverted into a gutter. (The diverted ink is recycled back into the supply reservoir.) Continuous-flow printers usually have better print quality than the drop-on-demand types, but their cost—$3,000 and more—restricts them from personal use.

With either technique, the resolution of a typical ink-jet printer is from 140 to 240 dots per inch. "But the apparent sharpness of text and graphics from an ink-jet printer is often better than from other printers," claims Dave Ball, manager of technical development at Epson.

The reason? "It's because the ink spreads slightly when it hits the paper," Ball explains. "If you've ever watched rain hitting a windowpane, you've seen the individual drops start to run into one another and meld together. That's exactly what happens in the ink-jet printing process."

The spreading minimizes the "dottiness" of the print, Ball says. I discovered excessive spreading can also blur the image around the edges. Arnold DenBleyker, marketing manager for ink-jet printers at Siemens, agrees: "The key is that the ink should spread out a little bit. If it spreads out too far, then you see nothing but fuzzy printing."

Even with the ink spreading, the size of each dot produced by an ink-jet printer is incredibly small. "The nozzle openings in our PT-90 are 50 microns," continues DenBleyker. "When the ink drop hits the paper, it squishes out to about six mils." That's two mils less than the dots created by some of the best impact dot-matrix printers.

The least expensive ink-jet printers have only one ink channel; a full line of text is made with several passes of the print head. This makes printing painfully slow: 15 to 25 cps. Multichannel ink-jet printers, with four to 32 nozzles, print faster. For instance, the Epson SQ-2000 has 24 channels and prints up to 176 cps.

Color ink-jet printers have three or four channels, one for each of the three subtractive primary colors—yellow, cyan, and magenta (and sometimes a separate channel for black). With ink mixing, ink-jet printers can produce up to seven distinct colors, plus more with dithering.

Ink-jet printers are plagued by one problem: During unused periods the ink can dry out and clog a nozzle. If that happens, you must operate a lever or press a button (depending on the model) until the clog is pumped out. But some new printers clean themselves. The Epson SQ-2000 is perhaps the most sophisticated. Says Epson's Ball, "During printing, the unit occasionally pauses to flush out each of its 24 ink channels with solvent. During periods of rest, a suction cup closes up the nozzles and prevents the ink from drying out."

Laser

By far, the most technically advanced system is the laser printer. It uses a tiny pinpoint of focused, coherent light to create images on paper. Laser printers are based on the same technology as the plain-paper copier to draw each character—out of a series of dots—directly onto a photoconductive drum. The drum picks up black toner where the laser light strikes and deposits it on the paper. Laser printers create text and graphics in black only (or a single color, using colored toner). Full-color laser printers aren't here yet, but they're not far away.

The majority of laser printers for personal computers are designed around the same electrophotographic system used in the Canon PC-20 and PC-25 personal copiers. Called the Canon LPB-CX, the system forms the basis of the Hewlett-Packard LaserJet Plus, the Apple LaserWriter, the Corona LP300, and several others. All of these laser printers are similar and have the same mechanical components. Their internal electronics and on-board software differ, however, and so do prices.

The disposable toner-drum cartridges for the Canon-based laser printers, which aren't compatible with those used in the Canon copiers, cost about $100 each and last a maximum of 3,000 pages. That's about three cents for the toner needed to print a page of text, or about the same as an ink-jet or thermal-transfer printer.

Laser printers have high resolution —a minimum of 300 dots per inch. The print looks nearly typewritten or typeset, but under close inspection, you can still see the dot-by-dot makeup of the print. Another advantage of laser printers is speed. The HP LaserJet Plus and Apple LaserWriter produce up to eight pages per minute; about 150 to 225 cps.

Alas, for all of their speed and high resolution, laser printers are expensive. Currently, there are no models less than $3,000, but the prices should fall. "Laser printers will track the trends in personal copiers and electronic equipment in general," suggests Archibald. "The prices should all drop at the same rate."

If he's right, don't be surprised to see a low-cost, ultra-quiet laser printer for under $2,000 by this time next year. In fact, prices for all non-impact printers should drop. "We think that, overall, printer prices will drop about 15 percent this next year," says Siemens' DenBleyker.

I can hardly wait. There must be a better way than stuffing my ears with cotton. PS

SOME MAKERS OF NON-IMPACT PRINTERS

ACT (Advanced Color Technology), 21 Alpha Road, Chelmsford MA 01824; **Apple Computer,** 20525 Mariani Ave., Cupertino CA 95014; **Brother International Corp.,** Eight Corporate Pl., Piscataway NJ 08854; **Canon USA,** One Canon Plaza, Lake Success NY 11042; **Corona Data Systems,** 275 E. Hillcrest Dr., Thousand Oaks CA 91360; **DEC (Digital Equipment Corp.),** 146 Main St., Maynard MA 01754; **Diablo (Xerox),** 901 Page Ave., Fremont CA 94537; **Epson America,** 2780 Lomita Blvd., Torrance CA 90505; **Hewlett-Packard,** 1820 Embarcadero Rd., Palo Alto CA 94303; **IBM Corp. (Information Systems Group),** 900 King Street, Rye Brook NY 10573; **Okidata,** 532 Fellowship Rd., Mt. Laurel NJ 08054; **PCPI (Personal Computer Products, Inc.),** 11590 W. Bernardo Ct., San Diego CA 92127; **PrintaColor,** 2830 Peterson Pl., Norcross GA 30071; **QMS (Quality Micro Systems),** Box 81250, Mobile AL 36689; **Quadrum Corp.,** One Quad Way, Norcross GA 30093; **Radio Shack (Tandy Corp.),** One Tandy Center, Fort Worth TX 76102; **Siemens Information,** 5500 Broken Sound Blvd., Boca Raton FL 33431

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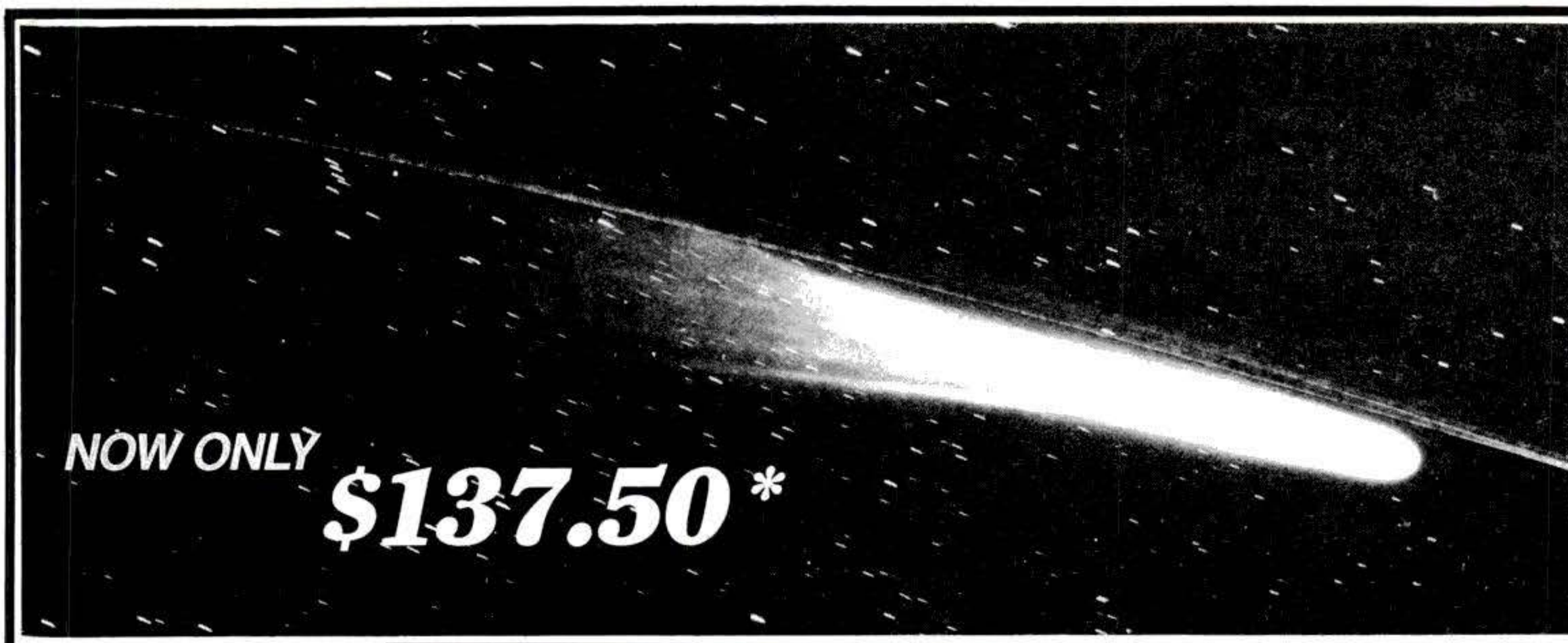

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Hot new tires

[Continued from page 77]

good enough to compete in showroom stock races. "We found that other manufacturers were making street tires with racing compounds that were starting to surpass our original-equipment tires," says Bob Stella of Goodyear's high-performance-tire engineering group.

"So we developed the VR S tire solely for the aftermarket," Stella says. "It improved our lap times because it has a different tread compound." Chevrolet, however, doesn't use the VR S on the Corvette because the tire has only half the tread life of the VR50. The VR50 is rated at 220 on the Federal Uniform Tire Quality Grading Scale versus 100 for the VR S. Companies discourage converting these ratings into estimated mileage, but some industry observers translate each 10 points on the scale into 3,000 miles of tread wear. Thus a tire with a 220 rating should theoretically go for 66,000 miles, according to this formula. It's highly doubtful, however, that a high-performance tire could achieve that much mileage.

Another Akron competitor, Goodrich, shuns the original-equipment car market—yet is the producer of one of the leading high-performance tires in the world, the Comp T/A. Goodrich recently introduced a new-generation Comp T/A (without changing the name or giving the tire a new label). Like its predecessor, the new Comp T/A is aimed at competitive drivers.

Despite the fact that the Comp T/A doesn't have to meet car-manufacturer specs, Goodrich has incorporated many of the same features in the tire as has Goodyear in its models. The new Comp T/A has a top-speed rating of more than 170 mph for certain cars. The tire has also bettered the old T/A's 1-*g* lateral-force rating on the skid pad by five percent, according to Gary Derian, product manager for the T/A radial. "Yet we've improved tread wear by 30 percent with a new compound and lowered the tire's rolling resistance, too," Derian says. The tire has a Uniform Tire Quality grade of 220 for tread wear.

Associate Editor Stuart Brown recently flew to Atlanta, Ga., to test Goodrich's new Comp T/A at the Road Atlanta racing circuit. "I was impressed with the cornering ability of the new tire," Brown reports. "Going around corners at more than 60 mph or cruising down a straightaway at over 90 mph, the Porsche 944 I was driving felt totally controllable with these tires."

Overseas tire makers—particularly Pirelli and Bridgestone—have a great influence on the high-performance European and Japanese cars. Pirelli's influence stems from its being the standard tire on many exotic cars and on the entire Porsche lineup. The Pirelli P700 is the Italian manufacturer's flagship tire.

Bridgestone is the newest entry in the ultra-high-performance tire field. The preeminent Japanese tire company hopes its new Potenza RE71 will propel it to a greater share of the U.S. tire market. Porsche has already approved the new Potenza as one of its original-equipment tires after Bridgestone certified the model for a top speed of 162 mph. And Mazda uses the RE71 on the new RX-7. Toyota's MR-2 sports car also comes with the new Bridgestone tire. The RE71 has a substantially lower tread life than the Goodyear and Goodrich tires: 140 on the Federal Uniform Tire Quality Grading Scale.

Driving in the rain

"To get higher grip, we have to sacrifice some tread life," says Hiromi Hamaya, technical service manager for Bridgestone's international operations. The RE71's grip is apparent when you drive a car with the new tire. Jack Keebler first drove the Potenza RE71 at Bridgestone's test track in Tochigi, Japan, last summer. "Its handling on the Porsche 930 was outstanding," Keebler reports. "The RE71 gives you a tremendous feeling of control."

I had an opportunity to drive a Porsche 911 with RE71s during a driving rain at the Sakura International Raceway near Nagoya recently and had a similar experience. The RE71s helped to tame this hard-to-handle Porsche.

An increasing number of sporty cars are on the way that will soon make use of the new generation of supertires. At the same time, there's a growing movement in the U.S. to adopt some kind of speed rating system for tires similar to the one used in Europe and Japan: H-rated tires are certified for speeds of up to 130 mph, and V-rated tires are certified for speeds above 130—all the way up to the limits of the vehicles. In the case of the Goodyear VR50, the speed is 156 mph because that's what the Corvette tops out at. The Bridgestone and Pirelli tires are certified up to the top speeds of Porsche cars. And Goodrich has certified its Comp T/A for speeds of up to 170 mph.

But why do we need tires that can travel at such high speeds when there are no roads in the country where you can drive that fast? "The reason," says Goodyear's Fred Kovac, "is that a tire that's certified for 180 mph is a better tire at all speeds—even down to 35 mph. And the technology helps to make all car tires better." PS

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4-Wheel Steering

[Continued from page 65]

Then I tried a number of low-speed maneuvers. The results were not as clear cut as with the high-speed tests —until I started turning the car in a tight circle. The 626 seemed to turn in its own length. It doesn't actually do that, but Furutani told me that the car's turning radius is about 1.6 feet shorter at 12 mph than a conventional 626.

My last test with the four-wheel-steering 626 was through a one-kilometer (0.62 mile) handling course with tight, twisting turns. I drove through the course at 40 mph with only two-wheel steering, and the car swung wide around the turns. Then I switched to four-wheel steering and drove a little faster—at 45 mph. The car hugged the inside of the corners in this mode and displayed considerably more crispness in handling.

My tests were informal, and the engineers urged me to hold down my speed because the prototype car was a fragile engineering test-bed. I also was unable to obtain solid performance data from the auto makers. My inquiries were answered with vague approximations of improved performance: "Just drive it," I was told, "and you'll see the improvement." My limited experience confirms that claim, despite a lack of hard performance numbers.

Catching up

Why haven't we seen four-wheel steering in cars before? After all, farm and construction machines have had rear-wheel steering for many years. Mazda's Yasuda says his company received its first patents on four-wheel steering in 1965. "But it's a long road from patenting a mechanism to making it commercially practical," Yasuda says. So what makes the '80s the right time for four-wheel steering? "We had to wait until computers and actuators became small enough and cheap enough," says Yasuda.

Now that the computers and actuators are available, it seems that four-wheel steering is on a fast track. That doesn't mean only high-performance cars will get the system, however. In fact, says Mazda's Takashi Kuroda, the first car his company brings out with four-wheel steering—in two years —will be "an ordinary car, not a sports car."

What will four-wheel steering cost? The Skyline's optional four-wheel-steering system costs about $500 in Japan. Mazda's system is expected to come in at about $700.

How will drivers respond to four-wheel-steering? If they're like me, once they've tried it they'll never want to drive without it. PS

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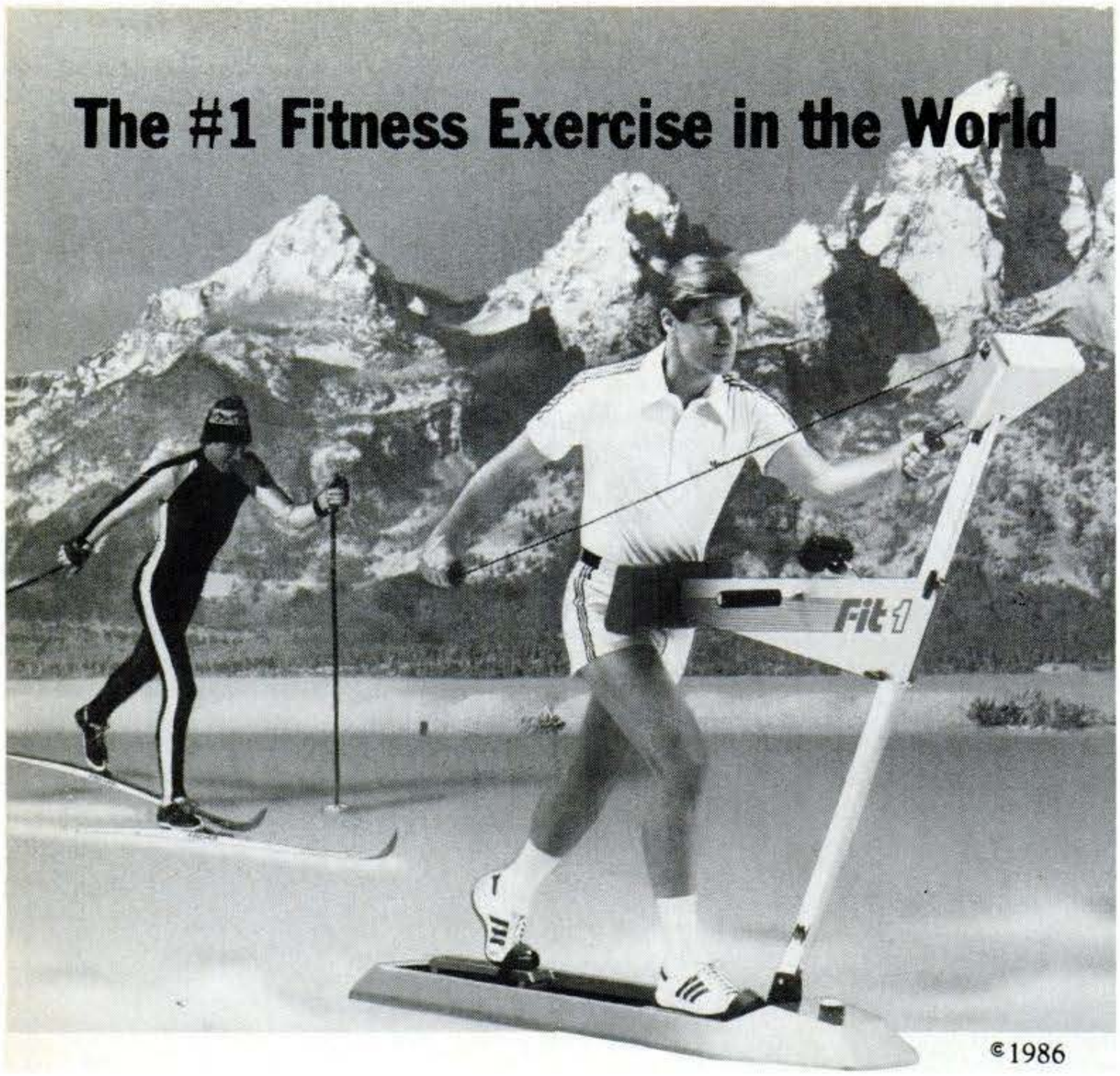

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[Continued from page 79]

beat Vector!" He was referring to the three-wheeled vehicle built by Al Voigt that had set a long-standing single-rider vehicle record of 58.89 mph back in 1980.

Actually, the first vehicle to beat the single-rider Vector's record was a tricycle built by Don Witte. It made a 61.94-mph run last August in Colorado; Hreno's vehicle officially took the title of fastest bicycle. (As PS went to press, I learned that a bicycle built by Gardner Martin of Freedom, Calif., and ridden by Fred Markham at a level location in the Sierra Nevada mountain range was officially clocked at 61.44 mph.)

If there's a trend afoot, it seems to be toward two-wheeled machines. "I think the two-wheelers have more of a future. It's easier to make a two-wheeler go faster because it has one less wheel hole in the fairing than a three-wheeler does," says Glen Brown, president of IHPVA.

PHOTO BY SANDRA SIMS-MARTIN

Crashing at 60 mph didn't stop Gold Rush: Fred Markham (right) climbed back in and set world's record of 61.44 mph. The 35-lb. two-wheeler has an aluminum frame based on Gardner Martin's Easy Racer recumbent.

"Wheel holes are critical to aerodynamics," Brown explains. "Less than half the drag is on the outside of the fairing; a tremendous amount of drag comes from air entering the wheel holes." Two-wheelers are also taller and narrow at the bottom, so they stay above the ground effect, which can trap air underneath and increase drag.

Getting the fairing's shape right is all-important. Brown describes "wind tunnel" testing on a home-builder's budget: "You attach wool tufts to the fairing, and then follow the HPV in a car to watch the way the air flows. The tufts should point straight back."

Now the question is, Who will build the first single-rider vehicle to go 65 mph and grab the $17,000 Du Pont Prize for Human-Powered Speed? Some predict the coveted award will soon be claimed as HPV designers on both shores of the Atlantic field increasingly fast machines. PS

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By STEVE MERCALDO

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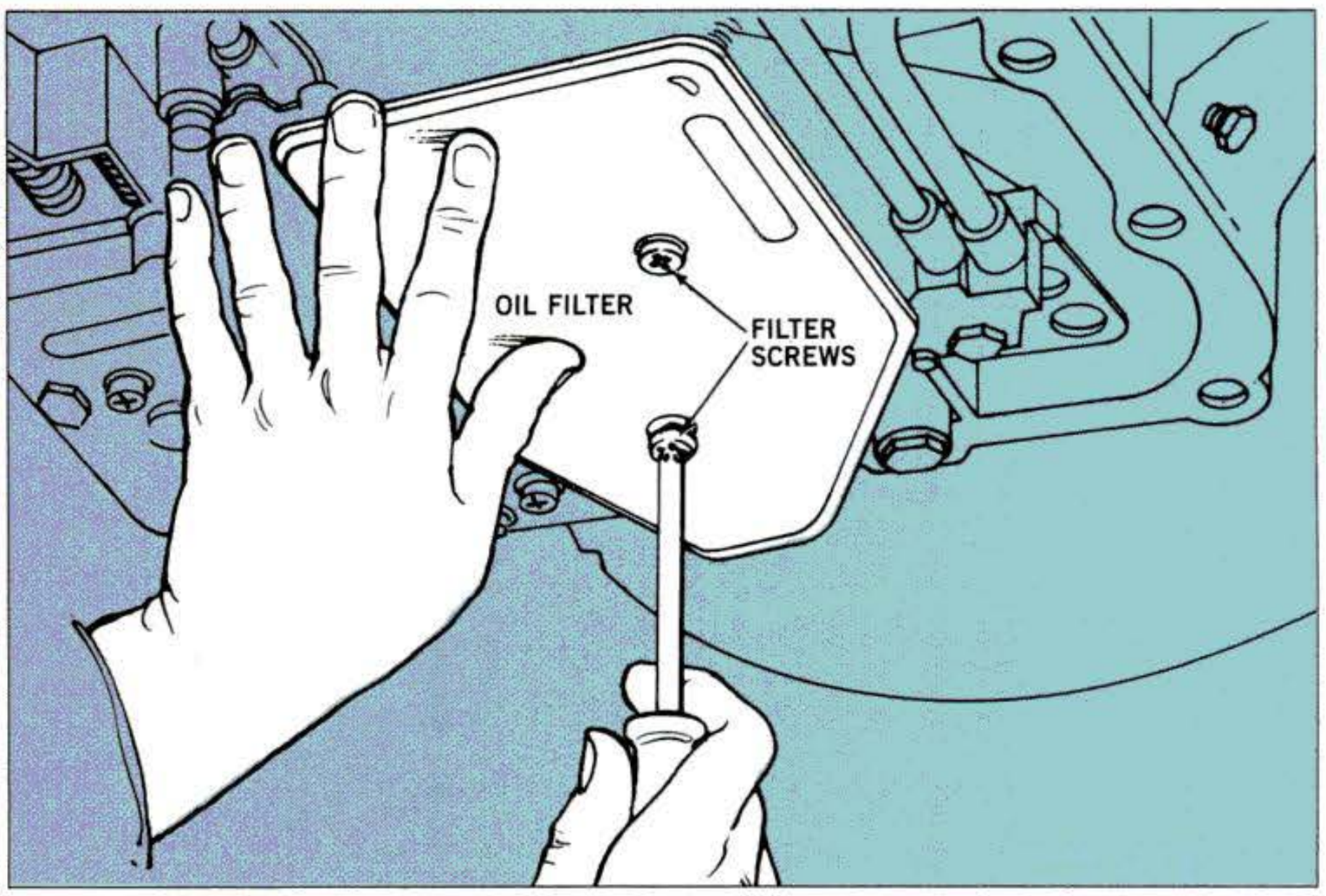
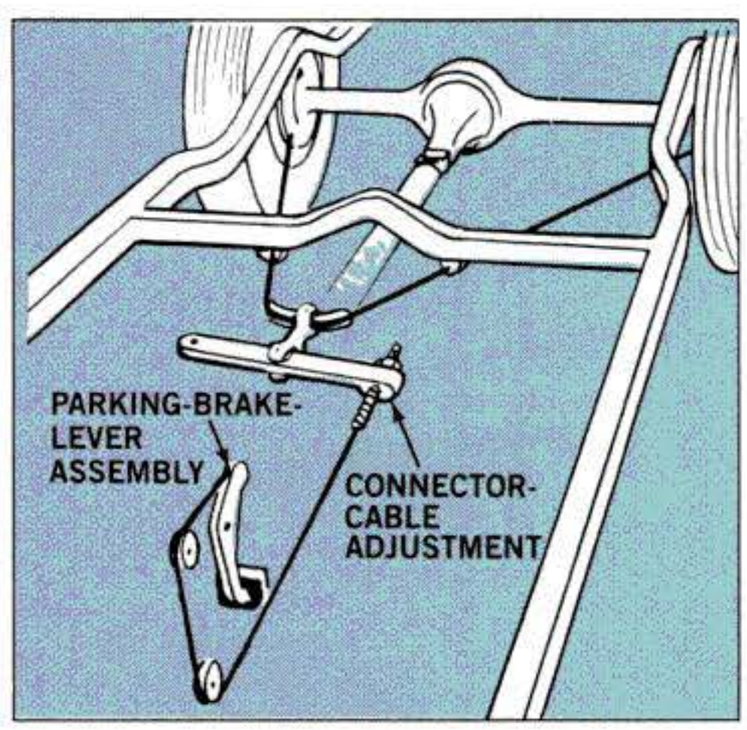


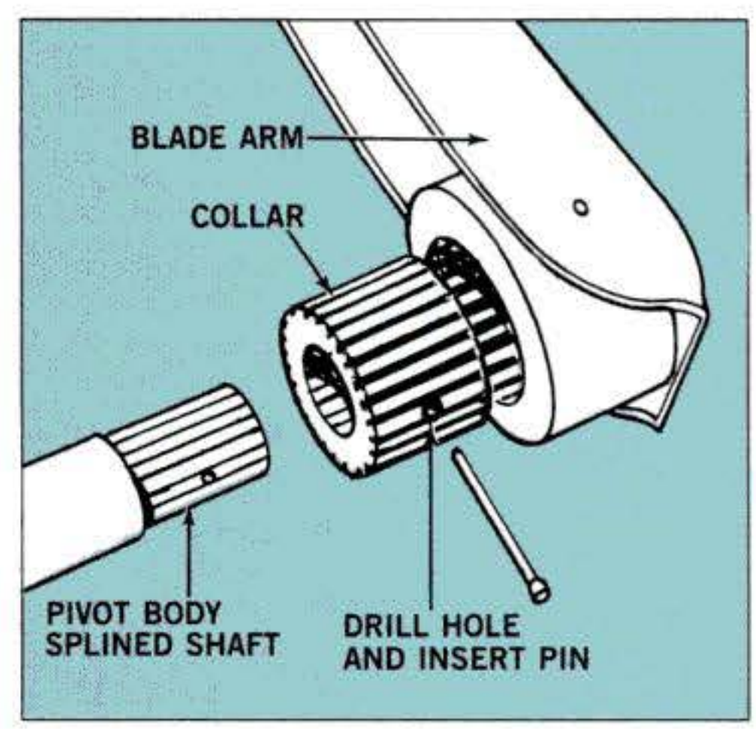
Transmission warning

When doing an automatic-transmission filter and oil change, use extreme care. Failure to reinstall a valve, gasket, or O-ring could result in early transmission failure. During removal of the filter's retaining screws or clip, hold the filter in place with one hand, then slowly lower the filter, paying close attention to any components or gaskets held in place by the filter. Always use a new filter gasket and O-ring. (A dab of transmission oil will hold the gasket in place.) Transmission oil and filters on vehicles in severe service should be changed at 15,000 miles or sooner.



Parking-brake adjustment

Jack and support the vehicle. Place the shift lever in neutral, then move the brake lever or pedal to half its full travel. Try to rotate the tires with two hands. If you can't turn the wheels, the adjustment is correct. If the tires rotate, turn the adjustment nut until they lock. (Check for drag when the brake mechanism is released.)



Wiper trick

Removing a wiper drive assembly to replace a damaged wiper pivot shaft is tough and expensive. Here's a trick that may save you the trouble: Drill a small hole through the wiper's splined collar and pivot shaft. Insert a pin (a small brad works well) through the hole. Use caution when drilling the collar—it's usually fragile.

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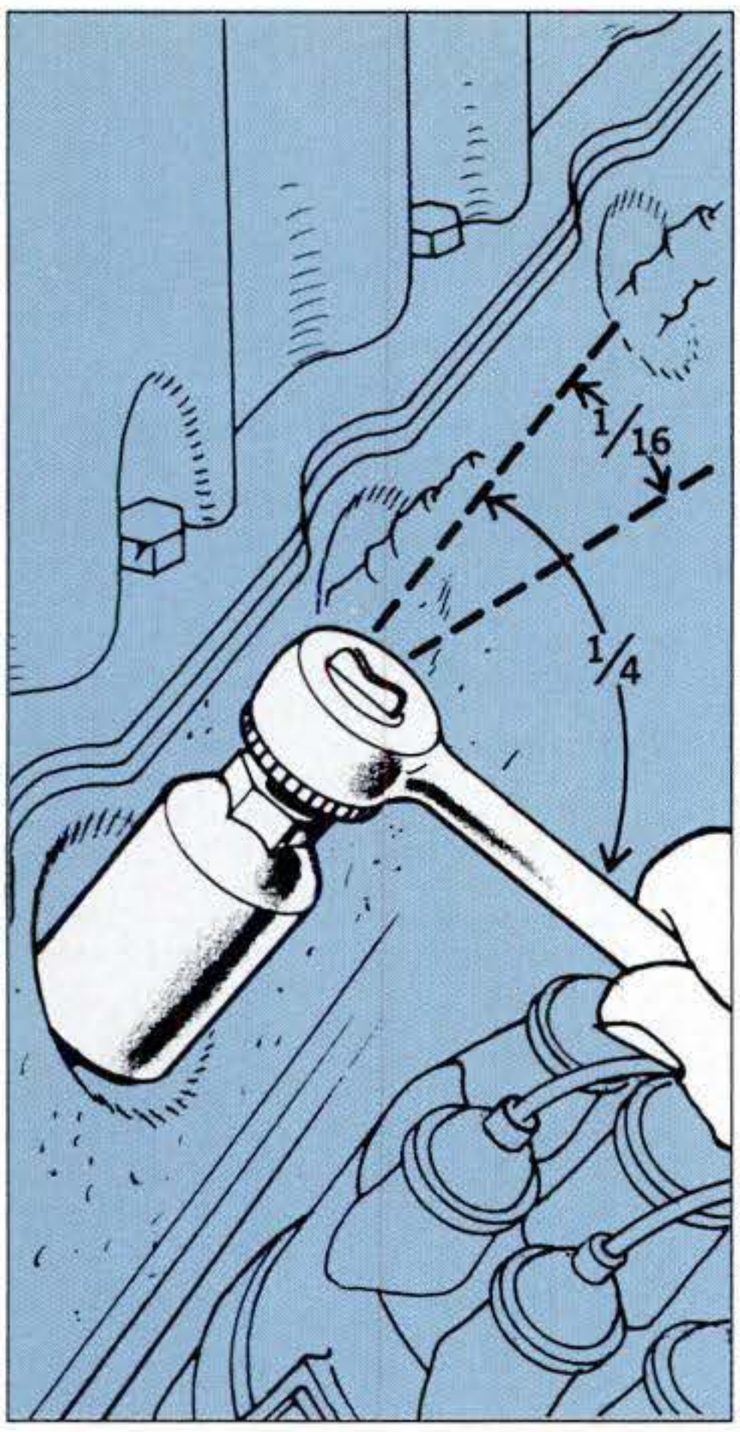
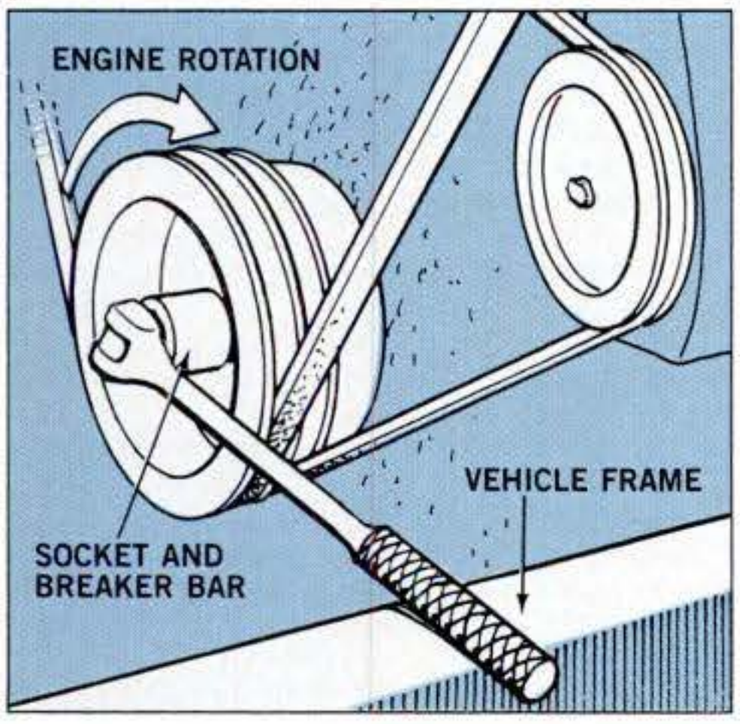


Spark-plug tip

Ideally, spark plugs should be tightened with a torque wrench. But it's often impossible to snake a torque wrench into position. Use this rule of thumb: On gasket-seated plugs, thread the plug in by hand, then tighten ¼ turn. Tighten taper-seated plugs 1/16 turn past finger tight.



Vibration-damper removal

Applying muscle to a vibration-damper pulley bolt just rotates the engine without removing the bolt. To remove it, try this: Position a socket and breaker bar on the pulley's bolt. Allow the bar to rest on the frame. *Carefully* bump the starter to loosen the pulley bolt. (Disconnect the ignition wires to prevent the engine from starting.)

QUARTZ
SPORTS CLOCK
KIT
$4.95
($12.95 Value)

OUR WAY OF SAYING WELCOME TO CLOCK-MAKING

Klockit's colorful new Sports Clock Kits can turn every sports enthusiast into a clock maker! Kits go together in just minutes. Each includes 6'' acrylic dial, our super accurate American made movement—with an unconditional 3-year warranty—plus hands and hardware. **$4.95 includes postage and handling**, our color catalog and ''Clockmaking Ideas'' pamphlet. Hurry...offer expires February 28, 1986!

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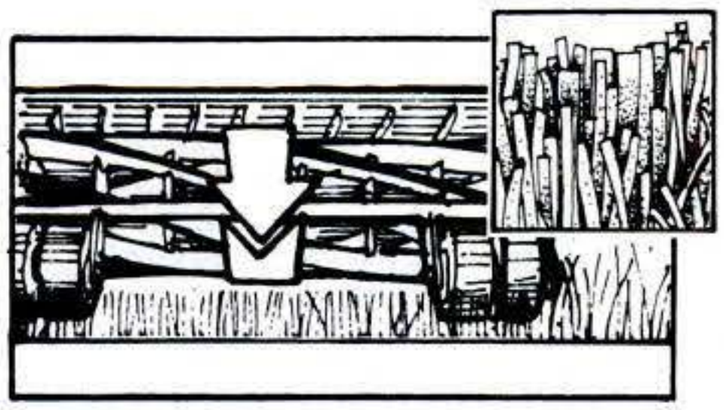
CALL TOLL FREE 1-800-KLOCKIT (556-2548)
Phone Hours Mon.-Fri. 8-8, Sat. 8-4 (CST)

Homeowners!

Re-Discover the Reel!

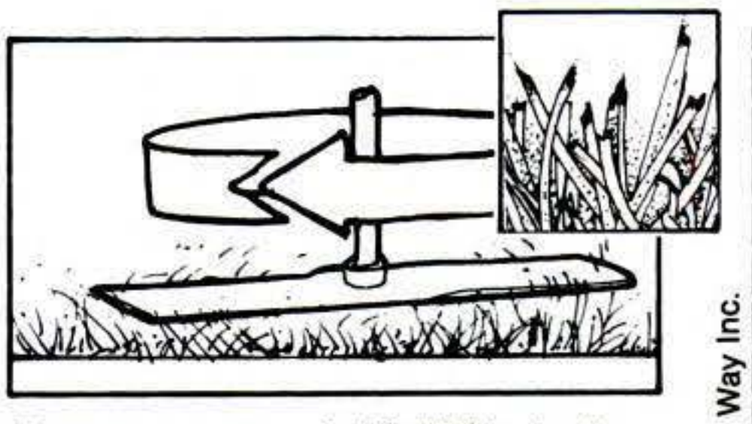
...for lawn quality and beauty *far better* than even the best rotary mower!



The Garden Way Reel Mower cuts grass cleanly with scissor-action, leaving a smooth, green, healthy appearance.

Now from Garden Way--
makers of the famous TROY-BILT® Tiller— —a professional quality, self-propelled Reel Mower that's perfect for homeowners who want a superior quality lawn!

Send today for FREE details and Introductory Savings



Rotary mowers cut with "Whipping" action, which tends to rip and tear grass, causing tips of grass to become jagged and brown.

©1986 Garden Way Inc.

Garden Way Mfg. Co., Dept. A248 3 16
102nd St. and 9th Ave., Troy, NY 12180

☐ **YES!** Please send me complete details on the Garden Way Reel Mower, including prices and special limited-time savings.

Name _____
Address _____
City _____
State _____ Zip _____

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It's Your Turn To Get Rich!

I Became A Millionaire In 36 Months, You May Do Better!

My name is Adam J. Lear and I have been in business for myself for the past thirty six months. My income for the past year was over $1,200,000.00 and I would like to show you how I made it.

But first, why am I doing this for you?

Simple, one and a half million dollars is about all one person and his family can make in one year, after that it takes several employees, your own office building, and over 40 hours a week of hard work. I am not willing to do that.

Besides in the last thirty six months I have been able to earn over three million dollars by applying the information you will find in "It's Your Turn To Get Rich." And out of the $3,000,000.00, I have been able to put away a sizeable nest egg for myself and my family. One that can produce a retirement income of up to $100,000.00 dollars a year (tax free) for the rest of our lives. How much money does one family need anyway?

Listen to me for just a minute. If you need to start making big money next month, up to $100,000 or better, then your turn to get rich is NOW. It has often been said that anything is easy to do once you know how. And this is especially true of making money, because becoming wealthy is really knowing how to spot just one "unique" money-making opportunity in your lifetime, and knowing how to take advantage of it. *That is what I am going to show you how to do.*

If you are serious about becoming wealthy, then order "It's Your Turn To Get Rich!" TODAY! In it you will find how I built a million dollar income from nothing. I will also show you that I know what it's like to struggle to survive, to find yourself financially trapped, and how to fight your way out by capitalizing on a well kept secret opportunity.

Let Me Give You A Small Sample of What "It's Your Turn To Get Rich" Will Do For You.

If you need $25,000 Quickly, on page 94, I will give you the inside secret of how I pocketed Twenty-Five Thousand Dollars in thirty days when I first started three years ago. Or if you need money sooner than that, to maybe pay off some overdue bills this month, I will show you how to make up to $10,000 in one day by using the secret information on page forty four.

Let me jog your memory for a moment! Was it last week, or was it last month, when you desperately needed just a few hundred dollars, maybe it was a thousand, to meet your overdue bills that month. Recall how you worried and worried how you were going to raise the money. You tried borrowing it, but no one would lend it to you. Then you thought of getting a part-time job for the next two months. Remember how you searched and searched the classified ads for employment, and in every classified ad you were either over qualified or you would be too embarrassed if some of your friends saw you working such a low paying job.

That's All Going to Change Now! No more searching the classified ads for you. Try "It's Your Turn To Get Rich" and I guarantee that your life will change.

I Promise You Won't Be Disappointed!

But before I go on. Let me share with you a couple of statements I wish someone would have pounded into my thick head about five years ago.

If you need help "Right Now" this very minute, **then I want to help you,** but for the life of me, I would like to know, when are you going to say, "Enough is enough"? When are you going to stop wasting your precious time, working for someone else? "Will it be next week or next year?" **Don't get me wrong.** I am not trying to insult you, nor do I want you to quit your job if you are happy with it. All I am trying to tell you is that, every day, brings new opportunities. Some good and some bad. Things may get better for you next week, without "It's Your Turn To Get Rich", then again they may not.

But if things don't get better for you and you decide to give "It's Your Turn To Get Rich" a try, I promise to show you an exciting and different way to make money that you have never seen before. It's an **"Entirely Different Approach" to making big money that I think will take this country by storm in the next twelve months.**

But first let me ease your mind. If you are somewhat skeptical, and believe me I certainly was when I first started out, then let me try to ease your mind a bit. I know you've probably tried all the money-making methods on the market. And you've probably read all the books offered about making big money from New York, to California.

I have too. I have sent for more money-making methods than I care to count. All with the same results. Nothing!

Now Here's What You Are Going To Receive From Me!

"It's Your Turn To Get Rich" will help you. **It is designed to help you make money next week!** Let Me Further Assure You By Saying: I am Not going to send you some crummy looking booklet, typed on someone's home typewriter. **What you are going to receive is a fantastic "Supercharged" money maker.** In a handsome 160 page publication that is completely designed by a professional publisher, with a full color cover. There are 160 pages altogether, about 130 pages of text and about 30 pages of exhibits, pictures and illustrations. There are charts, start on a shoe-string budgets, detailed operating instructions, and all kinds of **hard-to-find secret business information.**

Let me level with you. I know you don't know me personally, but for the sake of all that money that you might be able to make in the next twelve months, up to one million dollars, I strongly suggest that you order now.

If you do. You will find that the information I will be sending you has never been revealed before in any book, newspaper, or magazine."

In addition, you will find there is:
"No Investing in the stock market."
"No pyramid or chain letter schemes."
"No door to door or telephone selling."
"And No Real Estate to buy or sell."

Stop! Before we go on, let me make this point clear!

Money is Not the most important thing in my life now. My Happiness is! And here's what happiness may do for you. I can't promise your days will always be this pleasant, but wouldn't it be nice to start your day like this..... As you step out your front door, in your blue jeans, a smile of happiness dances across your face. "Which car should I choose to drive today? The brand new $65,000 Ferrari Sports Car, the $42,000 Mercedes Sedan or will it be the $27,000 Custom Chevy Van?" You choose the Ferrari (the fastest) because you feel like moving fast today. The time is 11:00 AM. Time to stop by your beautifully furnished office. As you check in you ask your personal secretary to run to the bank and cash a $1,000 check from your private account. **It's a great feeling having a thousand dollars cash in your pocket at all times.** "Whoops it's almost 12:30," time to stop by and have lunch with a few friends, and then perhaps play a game of tennis or just spend the rest of the day relaxing around your yacht.

I know. **I know.** You may not live near the ocean! That's OK, **you can operate "It's Your Turn To Get Rich" from any part of the country.** *Why not move to a more enjoyable climate?*

Wouldn't it be nicer for you to enjoy life this way, instead of having to worry about a boss who is going to chew-you-out if you're a few minutes late for work tomorrow. Wouldn't it be nicer, not having to worry where you are going to get the money to fix your car if it breaks down next week. Of course it would.

Let me let you in on a little secret, if you haven't already guessed. I haven't been rich all my life. In fact, I started out very poor and believe me I know what it's like to have your only car break down, with no money to fix it. I know what it's like to worry about car payments you can't meet. Credit-Card charges you can't pay. A boss that you live in fear of, and the constant threat of recessions or layoffs. Boy, do I know. I've been there. I also know what it's like to be fired for no apparent reason, spend every cent you have in the world just to keep food on the table, and see your dreams of a better life go up in smoke.

"Stop and think for a moment." How long can you last without your job if you get layed-off next Friday? Two weeks or is it three?
How much money do you have in the bank, right now, today, $500, $1,000, or $50,000!

Don't Let Someone Else Control Your Life. Do something about it Today.

BUT WAIT! Before you order I must ask you to listen to this. I know you have never heard of Adam Lear. And right now you're probably thinking; "Sure, his methods may have worked for Adam Lear, but he's one in a million, the exception; he got lucky."

Well, you're wrong. I had no special education or business training. And I'm willing to bet your luck is better than mine. In fact, years ago, I used to think the way you may be thinking right now. Only the one-in-a-million guy could make it big; only the exception could beat the daily rat race.

Listen Closely! I know you don't know me, but did you ever stop to think **there are hundreds, maybe thousands, of people like me, making $250,000 to One Million Dollars a year** who don't reach the front pages of the newspaper. Did you ever stop to think that we don't want the publicity or celebrity status?
Let me give you an example of what I mean:
Have you ever heard of Mr. J. T. Brown of Westbury, New York? Well, he made over $2,300,000 last year following a simple, but enjoyable, money making program. How about Mr. Robert Major of Suncook, New Hampshire? His creative money making program took many people by surprise. Not many of his friends thought he would make it. But, he did. His income was $250,000 at the end of eleven months. Or have you heard of Mr. Ronald Halmi, self-made

Take The 24 Hour Test....

Place your order **"Today!"**

Try one of my secrets described in "It's Your Turn To Get Rich" the first afternoon. **Perhaps** start with the closely guarded information on page 44. Put it into operation for 24-hours. Mark down the exact time you started it, *"for your records only,"* and at the end of 24-hours if you haven't made $10,000 Dollars send the materials back and I'll give you your money back.

It's that simple. No Proof! No Questions Asked! Just A Complete and prompt refund.

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millionaire, of New York City who made $2,840,000 last year? Some people thought he was too lazy to become rich. Others didn't give him more than two months on his own; without a weekly paycheck. He proved them all wrong, he succeeded despite what everyone said about him.

These self-made millionaires probably didn't start out with any more money than you may have in the bank right now. They didn't have exceptional luck either. They just said to themselves, "It's time. It's time to take action now! We're not going to wait until we are unemployed, and flat broke. We're going to make our fortune now, before it's too late."

You Too, could start on your way to your fortune. If you do something about it now, not next week, or next month. But Now! Order "It's Your Turn To Get Rich" today, and let me prove to you how enjoyable my program can make your life. Send **$12.95** for your copy of "It's Your Turn To Get Rich!" this very day and I will show you how to do achieve success like you never thought possible.

But, before I go any further. Let me clear up any possible misunderstanding you may have.

I didn't write "It's Your Turn To Get Rich" and then expect to make my fortune. I made my fortune before I wrote the first word in "It's Your Turn To Get Rich!" In fact, while we're on the subject, the year before I wrote "It's Your Turn To Get Rich!" I made $1,000,000 dollars. The year before that I made $800,000. It's all Documented!.

The amount of money I made in the last thirty six months is documented and can be backed up with bank records and financial statements from my Certified Public Accountants: *Callaway, Inc., of Vienna, Virginia.*

To put it as sincerely as possible— the plain truth is— that nearly anyone can acquire the same money-making skills that I used to build a fortune almost literally overnight.

Then again, you may do better.

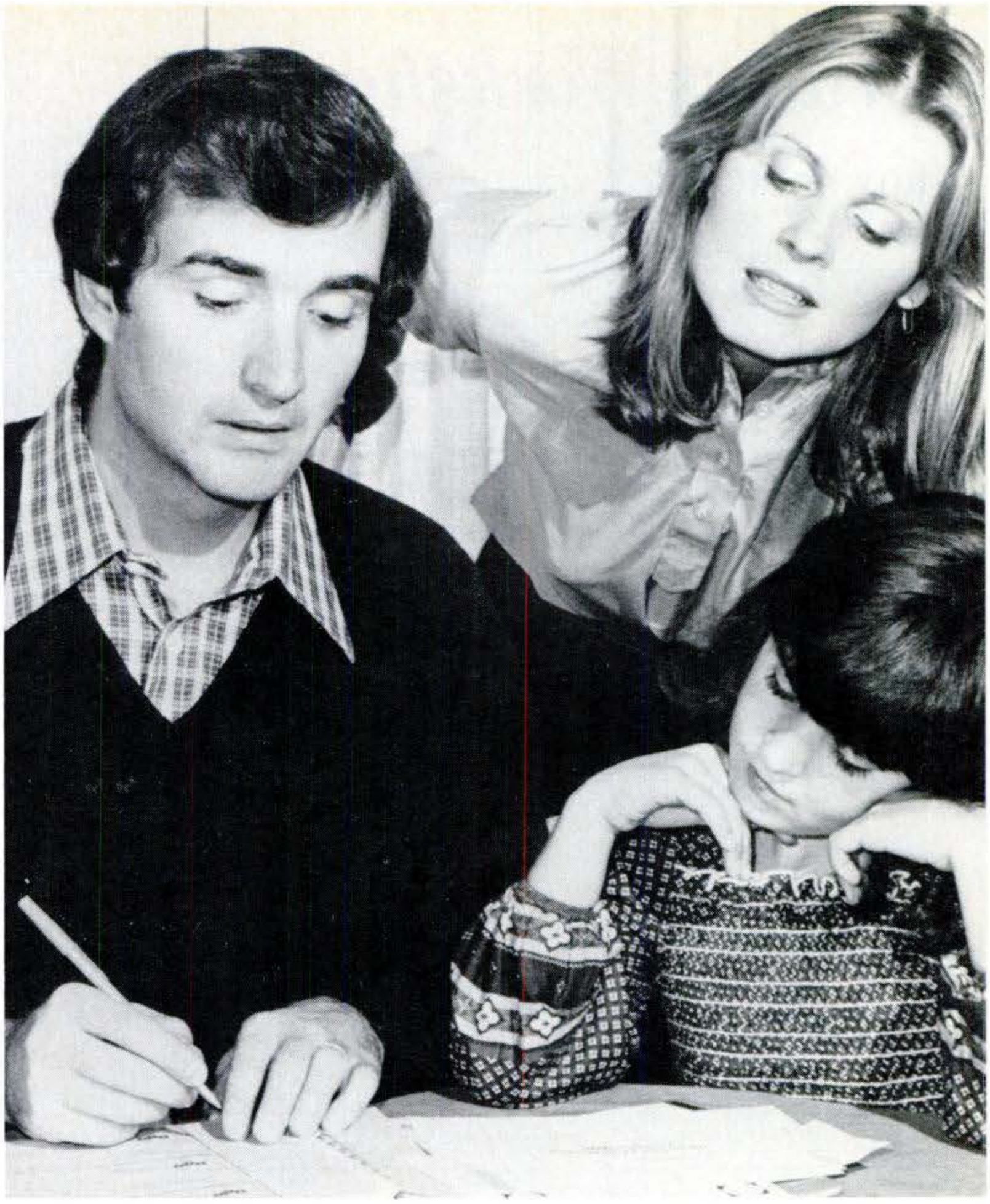
Here Is An Example Of What My Plans Can Do!

My Bank Deposits For The Past 12 months:

December	$93,444.23
January	$125,331.25
February	$135,221.40
March	$110,586.55
April	$76,556.76
May	$75,400.00
June	$90,229.00
July	$90,773.43
August	$83,765.90
September	$109,389.70
October	$106,705.35
November	$125,474.53

These are true facts. You can believe them or not. It's your choice. But I'll tell you this, I didn't have a lot of money to start with, and that's why I designed "It's Your Turn To Get Rich" with the average American in mind. I wanted anyone with no special education, and even no business training, to be able to start producing Big money immediately.

Don't Delay! Don't Let This Opportunity Slip By You! To let this opportunity slip by you would be a shame. If you turn this page without ordering, the opportunity may not be available to you again. (If you are saying to yourself. "I like this program, but I'll wait until tomorrow morning to order." Don't do it. Order now. You'll forget, and I don't want you to miss out on a once in a life time opportunity.) But most important of all, you may never know how great it feels having $50,000 dollars in the bank any time you need it for emergencies. You may never know what it's like owning new luxury automobiles. You may always wonder what it's like owning a home worth over $650,000 dollars in perhaps the best neighborhood in your hometown. Why don't you place your order for "It's Your Turn To Get Rich!" right now before you forget!



Bonus Chapter....

If you like staying at home and **watching TV Shows?** Then starting on page 105 I am going to give you a new and easy way to make up to **$75,000 Dollars.** Starting with as little as $25. (That's right. It's not a misprint. I said starting with $25 and making up to $75,000.) *This is not a joke.* Listen to me. There are hundreds of men and women operating this program this very day, and the marvelous part is that very few people, outside of this select group, have ever heard about it. Believe me, I just wish someone would have shown this to me four or five years ago. **It's Fantastic.** But, you just got to see it to believe it. It's Yours Free When you place your order for "It's Your Turn To Get Rich!"

"What if I don't like it?" You Can Return it!

I'll Give You A Full 90 Day Money-Back Guarantee. If at any time after receiving "It's Your Turn To Get Rich!" you want to return it, for any reason, do so. I will immediately refund your **$12.95** along with my appreciation and highest regards for you, for at least having given it a try. **There will be No questions asked! No hassles! No delays! Just a cheerful and prompt refund.**

In fact, if you feel a little uncertain about mailing a check to someone you don't know, you can: **Postdate Your Check For 30 Days From Now.** That way I can't cash your $12.95 check or money-order for 30 days after you get my materials. Use my methods in "It's Your Turn To Get Rich!" during that time. Then, if you don't think it's right for you, just send the materials back. And I'll return The Same Check You Sent Me ----Uncashed.

Take the time "Right Now". Pick up your pen. Fill out the Express"Order Form", and mail it in Today! In a few days time you will have "It's Your Turn To Get Rich!" in your hands. Use the information and start making big money with my Money-Making secrets. I think you'll see very quickly that it's everything I say it is and just by following the guidance it offers, you'll begin to realize your dreams of success as soon as next week. **"Or you can order by phone."**

Either way, I will give your order immediate attention the moment it arrives. And your copy of "It's Your Turn To Get Rich!" will go into the mail that very afternoon.

This Offer carries a full Money-Back Guarantee.
My Office phone number is (703) 450-4780.
All ORDERS ARE MAILED OUT THE SAME DAY

© *Adam J. Lear 1986*

To Order By Phone Call Toll-Free
1-800-528-6050 Ext. 217

Charge your order to: American Express — Mastercard — Visa. 24 hours a day. 7 days a week. "Operators on duty Sundays Too."

Note: Operators can only take orders. Thank You.

Your **Express** Order Form

Adam J. Lear
100 Glenn Drive
Dept. AA-3, P.O. Box 139
Sterling, Virginia 22170

Dear Adam, please RUSH me my program titled: **"It's Your Turn To Get Rich!"** only with the understanding that I have a full 90 days to test your methods. If I am not completely satisfied, for any reason, I may simply return "It's Your Turn To Get Rich" and you will immediately refund the full purchase to me. What's more, I can postdate my check for thirty days. On that basis here is $12.95.

Name _____

Address _____

City _____

State _____ Zip _____

Note: Because of the weight of the package I will be sending you, please add **$1** (in cash) for postage and handling. Thank You!

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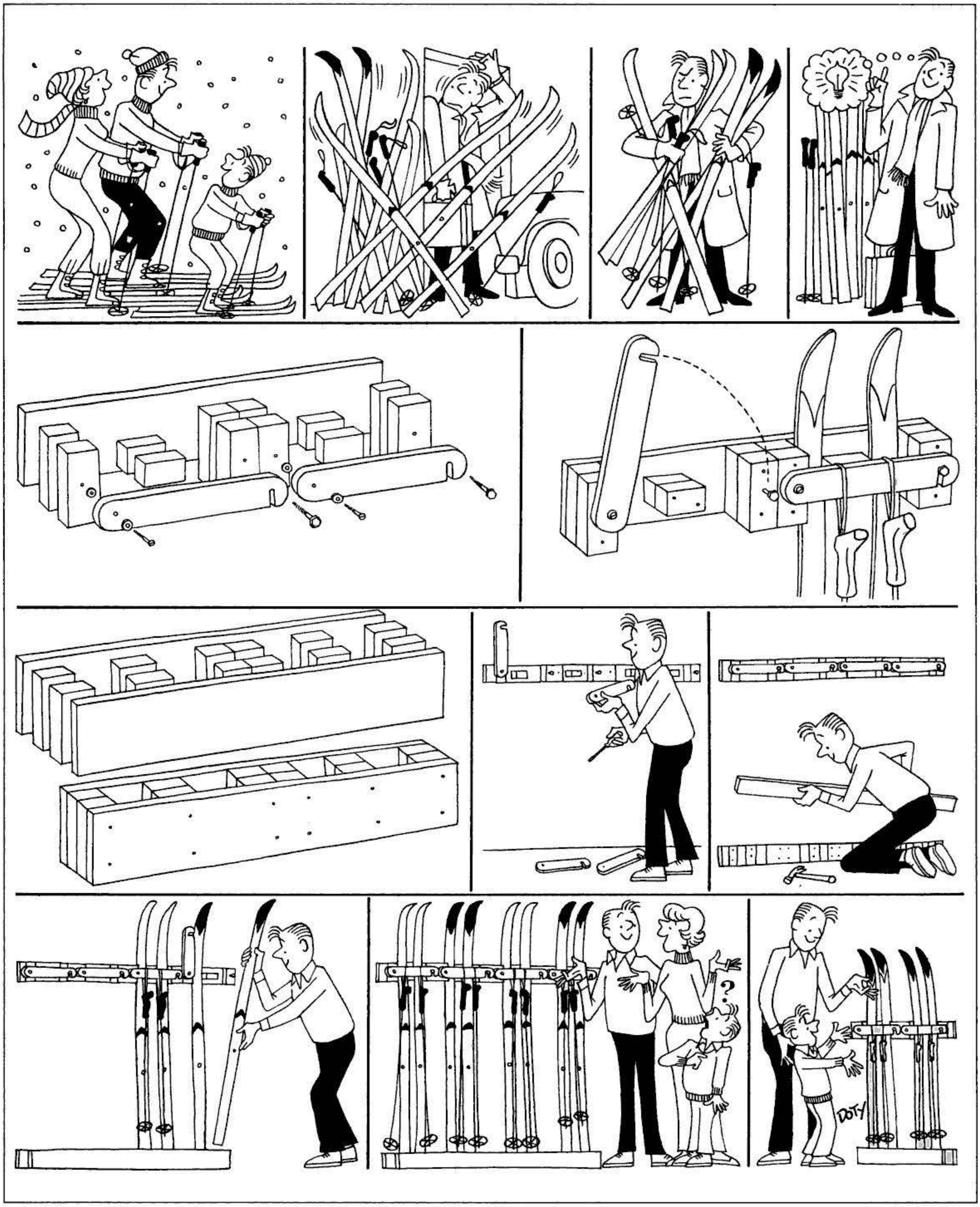
Wordless Workshop

By ROY DOTY

$50 to Gary Clark of Eaton Rapids, Mich., for this idea. Send yours (with Social Security No.) to Wordless, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. Only purchased ideas can be acknowledged.



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8 Ton Electric, 110 volt, **#1110..$459.00**
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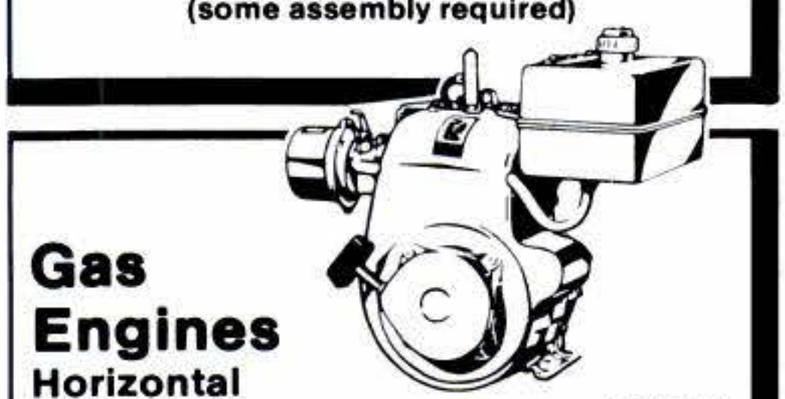
24 Ton, Low Profile, **#1142.....$1199.00**
(some assembly required)



Gas Engines
Horizontal

5 Hp. Tecumseh ¾" shaft, **#6051.....$129.95**
5 Hp. Briggs, ¾" shaft, **#6052.....$141.95**
8 Hp. Tecumseh, cast iron sleeve, **6081.$192.95**
8 Hp. Briggs, 1" shaft, **#6080.....$222.95**
10 Hp. Tecumseh, cast iron sleeve, **6010 $232.95**
10 Hp. Tecumseh, elec. start, **#60101...$289.95**
3-20 Hp. Horizontal & Vertical engines available at SUPER LOW DISCOUNT PRICES!

Heat Magnet

Clings to any magnetic iron or steel surface. Provides heat for pipes, pumps, engine oil pans & many other uses. Ship Wt. 1 lb., List $25.00.

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Log Splitter Parts

11 Gpm 2 Stage Pump, #1012.....$ 82.95
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16 Gpm 2 Stage Pump, #1056.....124.95

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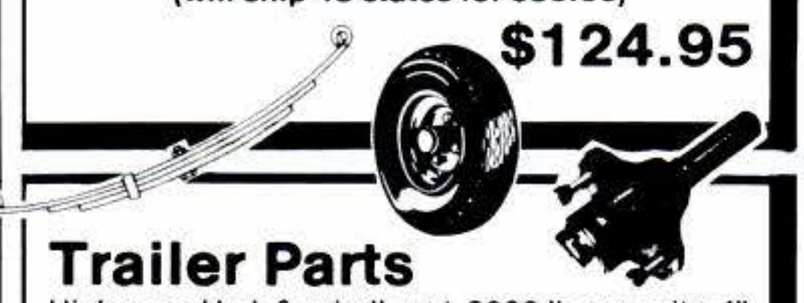
Auto Detent Valve, #2020.....$47.50
4x24x2" Welded Cyl., #902424..... $99.95
5x24x2" Tie Rod Cyl., #909524....$189.95
Much More in Stock at Low Discount Prices!

Utility Trailer Kit

Complete road ready kit. Easy assembly with basic tools. Load capacity 1060 lbs. Bed size 40" x 48". Includes fenders. List $279.00, Item# **12542**
(will ship 48 states for $30.00)

$124.95



Trailer Parts

High speed hub & spindle set, 2000 lb. capacity. 4" bolt circle, 4 hole, 2 hubs & 2 spindles, dust caps, tapered bearings, lug bolts & cotter pins **$37.50/set**

High speed trailer wheels & tires. Fits all 4 hole boat & snowmobile trailers.

Item#	Size	Ply	Cap.	Sale	tire only
1211	480x8	4	590 lbs.	**$19.95**	**$15.95**
1212	570x8	4	715 lbs.	**$29.95**	**$24.95**
1216	480x12	4	780 lbs.	**$32.95**	**$24.95**

Trailer springs, 1¾" wide w/eye center of 25½"

Item#	Capacity	Springs	Leafs	Sale
1250	1000 lbs.	2	2	**$22.00/pr.**
1251	2000 lbs.	2	3	**24.00/pr.**
1252	3000 lbs.	2	3	**27.00/pr.**

Single Spring Set Shackle, Item# **1255..$9.50/pr.**

Generators

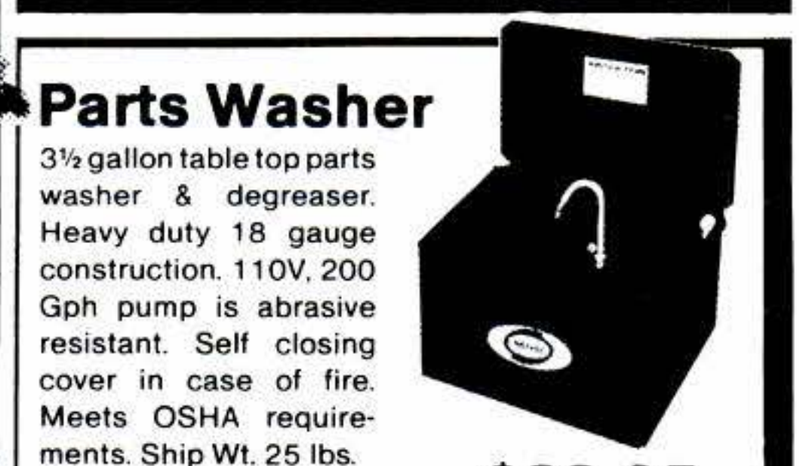
4000 Watt, 8 hp. Brigs, 33 amps @ 120 volts, 16.6 amps @ 240 volts, List $1009.00, Item# **16402**
$409.95

4000 Watt, w/elec. start, List $1143., Item# **16403**
$474.95

5000 Watt, 11 hp. Briggs, 42 amps @ 120 volts, 21 amps @ 240 volts, List $174.00, Item# **16404**
$579.95

5000 Watt, w/elec. start, List $1299., Item# **16405**
$679.95

(1 Year Warranty on Above Generators)



Parts Washer

3½ gallon table top parts washer & degreaser. Heavy duty 18 gauge construction. 110V, 200 Gph pump is abrasive resistant. Self closing cover in case of fire. Meets OSHA requirements. Ship Wt. 25 lbs.
Item# **1565** **$88.95**

Heavy Duty Tarp Sale
★ Lowest Prices Ever ★

Our Tarps are TOUGH! Up to 12 Mil Thick, Not 6 Mil Like So Many Others

Strong rot, rust & mildew proof polyethylene tarps with brass plated grommets every 3 ft. Sizes list are cut size

Item#	Size	Price
1770	6' x 8'	**$ 2.40**
1771	8' x 10'	**4.45**
1772	10' x 12'	**5.55**
1773	12' x 16'	**9.00**
1774	12' x 20'	**11.00**
1775	16' x 20'	**17.95**
1776	20' x 30'	**29.95**
1777	30' x 40'	**49.95**
1778	30' x 50'	**59.95**
1779	30' x 60'	**69.95**

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801 East Cliff Rd.
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Burnsville, Mn 55337
Dept.# 13926

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Address _____
City _____
State _____ **Zip** _____

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NO EXPERIENCE NECESSARY!

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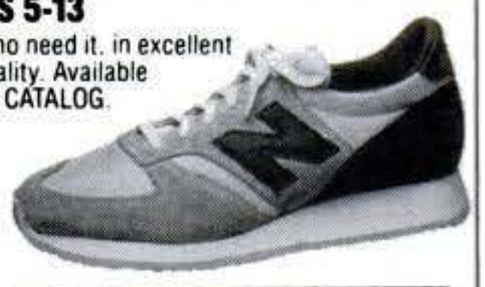

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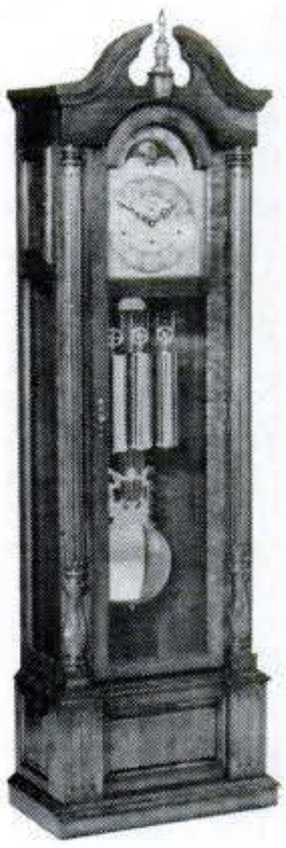

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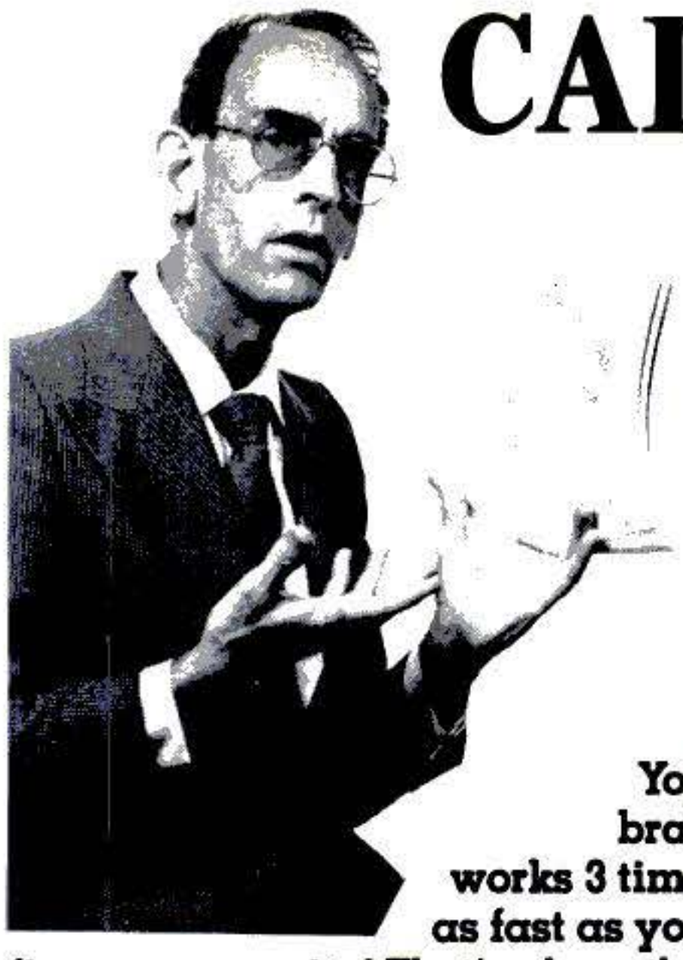


Your brain works 3 times as fast as your fingers can write! That's where the Calculator comes in — you can go three times as fast with your machine doing the dirty work.

It's easier and more interesting. And you'll understand it better when it's fun. (If you haven't yet tried out a modern scientific-statistical calculator, you're in for a pleasant surprise — see below!)

WHY MATH? To get a promotion or a new job. Just to hang on to that job you've got. To quicken your mind. To understand this world you live in. To impress people. Just for some fun you'll feel good about. (Read those letters below to see how it has worked for others.)

Do it at home... You can start right away and go as fast as you like! Put it aside while you're busy with something else — in short, *set your own pace!*

Lots of us like to avoid being compared with the other members of a class — we like to set our own standards. Too, we like to save the time and expense of going to a school or seminar. (Best of all, the rent is already paid so it's a lot cheaper to study at home — *read on!*)

Let's be honest. You wouldn't expect to learn to play baseball or chess by watching an expert do it. Math is the same — you'll need to do some work. BUT — with my calculator method, you'll see it's a whole new ball game!

THIS METHOD IS FRIENDLY! You can use it on your own. You follow interesting examples step-by-step with calculator keystrokes — instead of algebra.

Let me introduce myself — I'm Dr. George McCarty and I teach at the University of California. Tens of thousands of people like yourself have already used my guidebook to teach themselves calculus. Recently I have teamed up with another professor. We put those same tested and proven techniques to work for you in a new *Statistics Guidebook*.

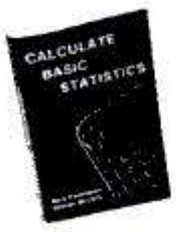
Even if you've had trouble with math, this method will work for you. Choose the one you want to learn, calculus or statistics (or both) and start *today!*

As pennywise Ben Franklin said, "An investment in knowledge pays the best dividends."

CHOOSE STATISTICS

It's used everywhere — to set insurance rates and to assess a drug's effectiveness, to detect a crooked roulette wheel and to measure lightbulb lifetimes, to audit the books and to find your position at sea.

People have always known that their experience was not a perfect guide to the future. Statistics shows us that uncertainty is not only inevitable but it itself is measurable.



You'll find out about this in my guidebook. You'll read informal explanations with detailed calculations for topics like "confidence intervals" and "contingency tables."

YOU'LL BE DOING Inference and Hypothesis Testing, the Chi-Square Distribution, ANOVA, Regression and Correlation, Non-Parametric Methods — they're all here.

SUPPOSE YOU HAVE ALREADY STUDIED STATISTICS. You'll use Quick-Reference Guides to go straight to a topic you want to refresh yourself on — then get *right-now* answers in your own field, business, biology, science, psychology, education.

The Guidebook is guaranteed to work with any calculator or computer. If you would like to start out with a fancy new machine, order my Statistics Kit which includes the guidebook and a TI-35 calculator which finds means and standard deviations at the touch of a button. It has an LCD display, 1000 hour batteries — the works.

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NEED TO EVALUATE functions, areas, volumes — solve equations — use curves, trig, polar coordinates — find limits for sequences and series? It's all here!

If you're in the biological, social or physical sciences, you'll be doing Bessel functions, carbon dating, Gompertz' growth curves, half-life, future value, marginal costs, motion, cooling, probability, pressure — and plenty more.

Important numerical algorithms are here, too: rational and Padé approximation, bracketing, continued fractions, Euler's method, Heun's method, iteration functions, Newton's method, predictor-corrector, successive substitutions, Simpson's method and synthetic division.

If you already have a scientific calculator, you can get just the *Calculus Guidebook*.

George McCarty

P.S. — YOU *CAN* DO IT! I'm certain I can show you this easy way to success with math, so *I guarantee it to you unconditionally* — if you are not satisfied just send it back for a prompt refund!

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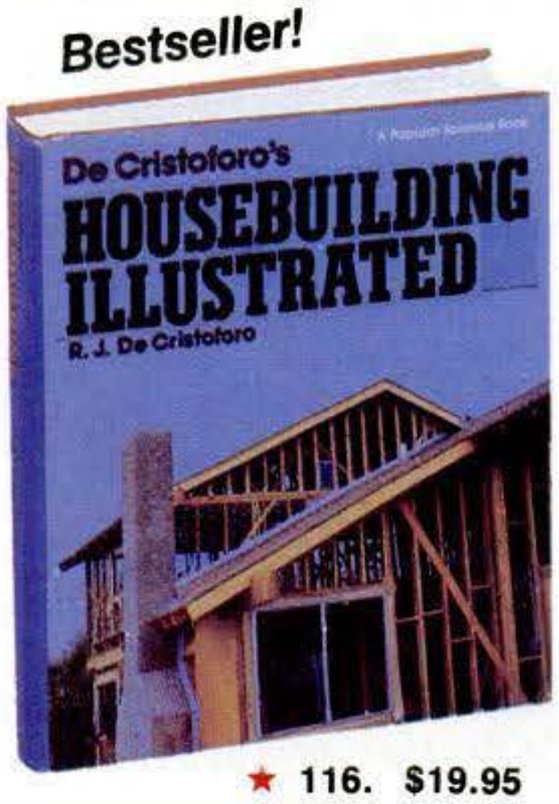

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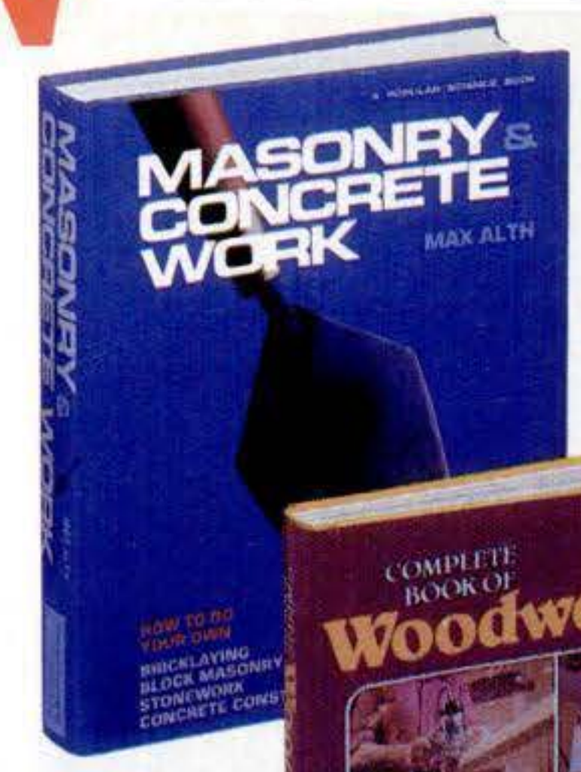

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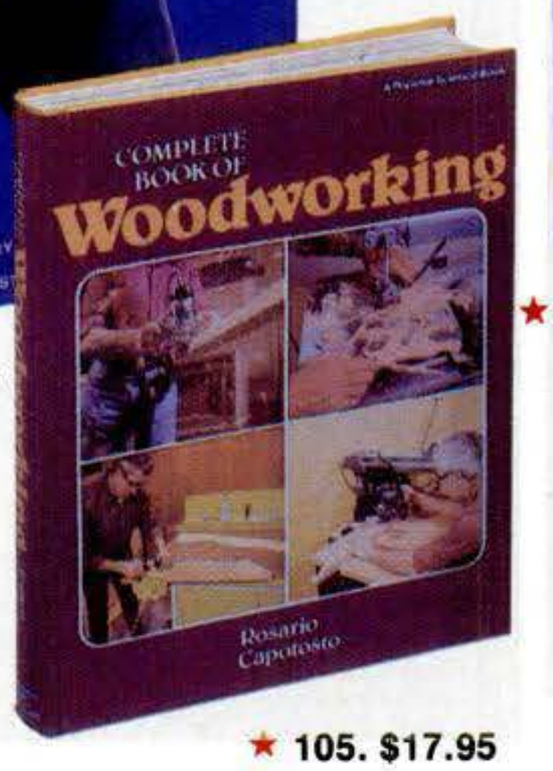

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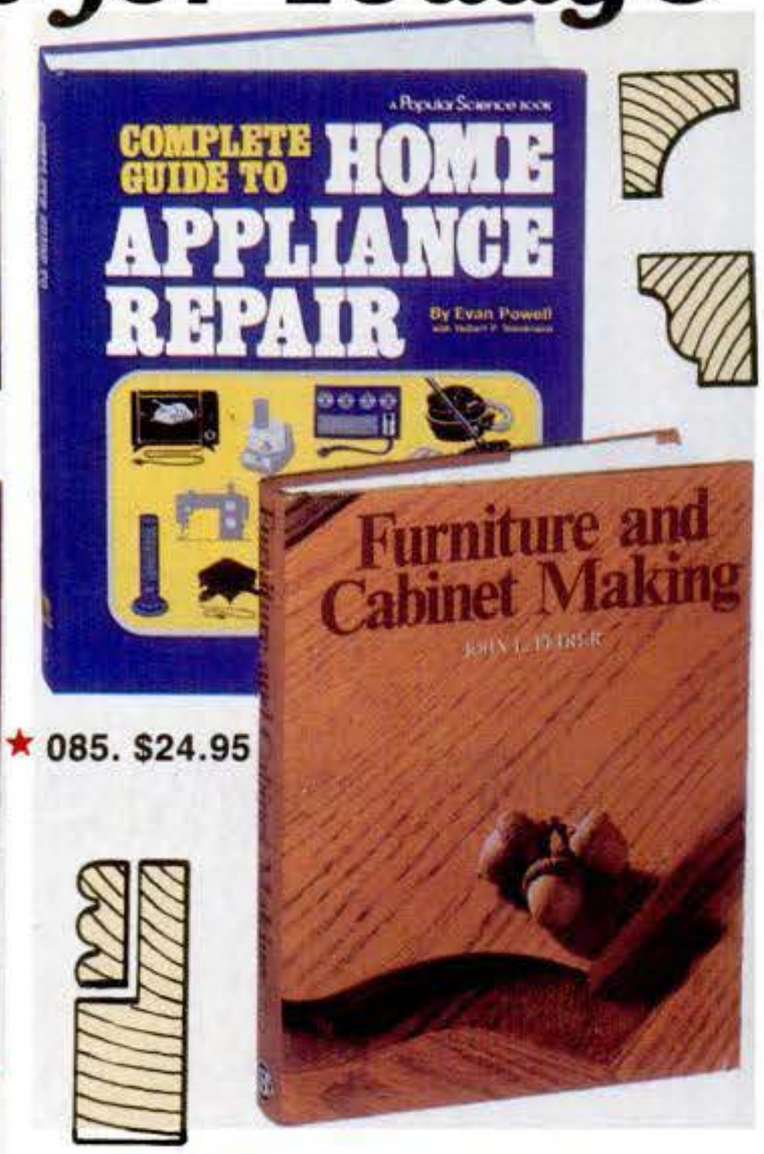

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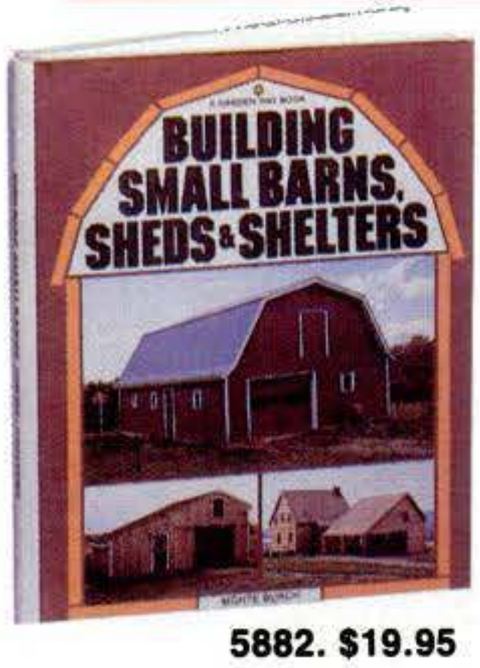

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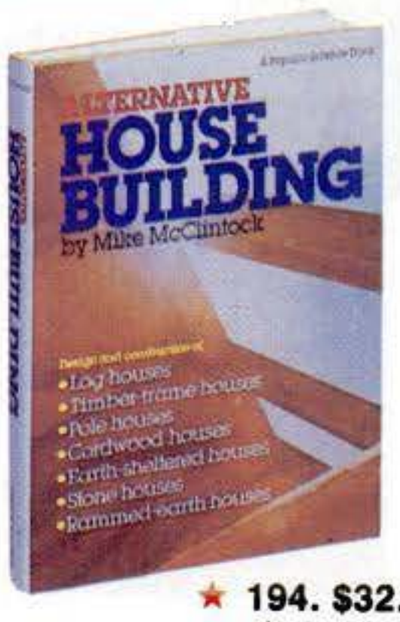

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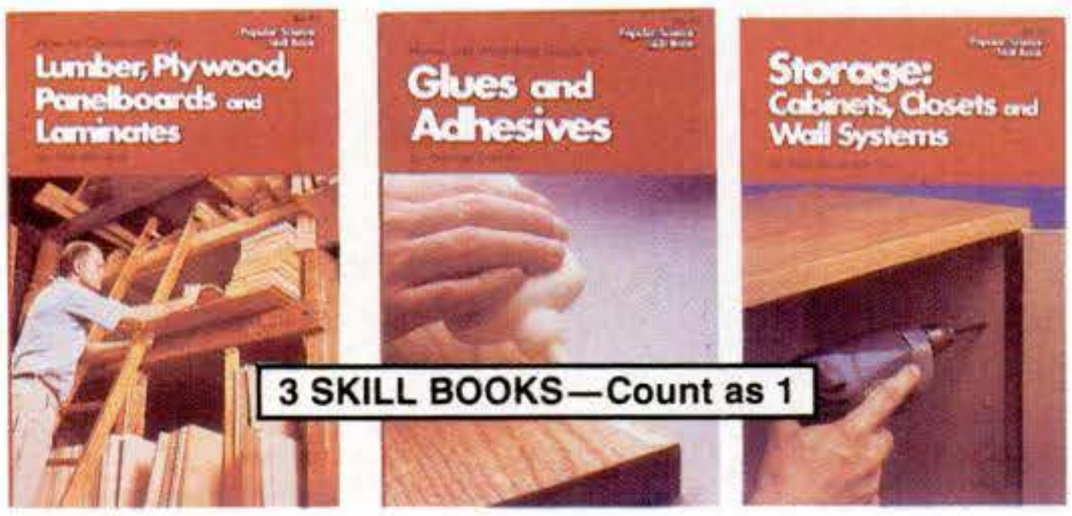

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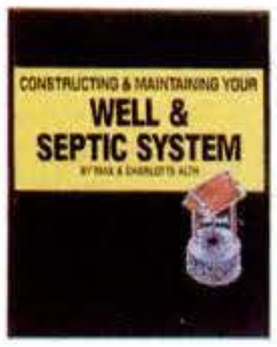

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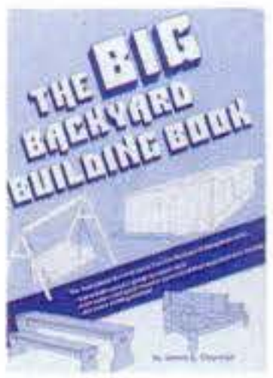

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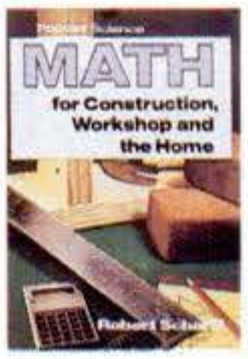

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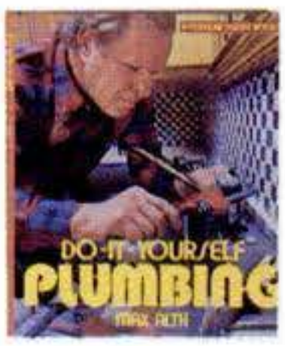

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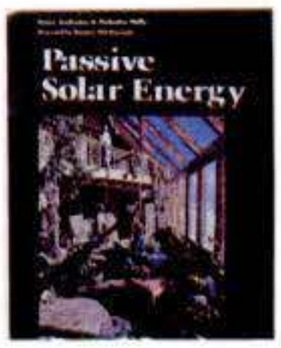

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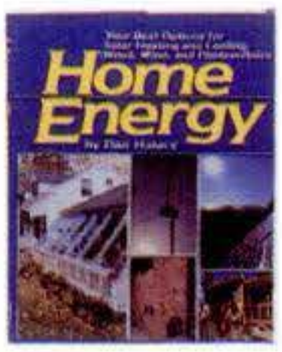

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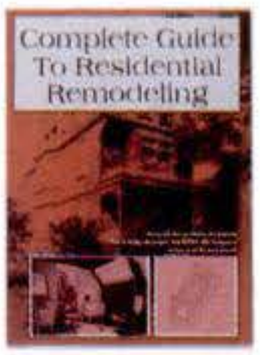

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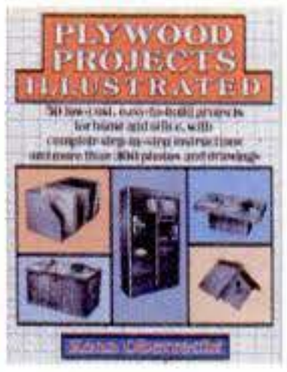

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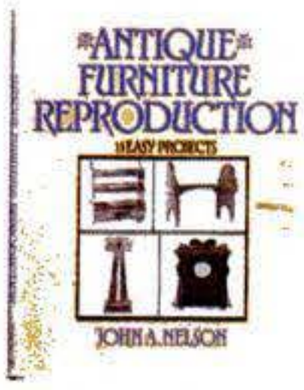

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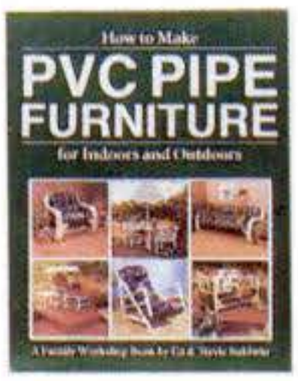

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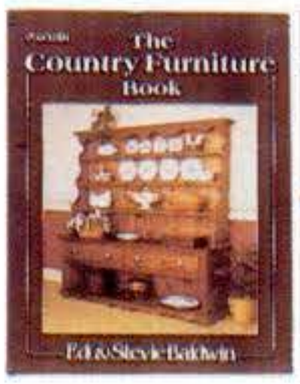

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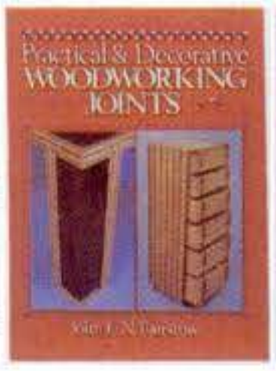

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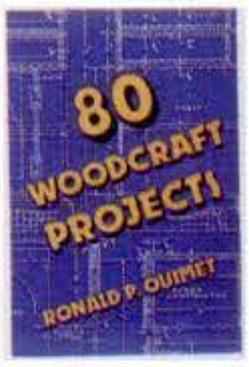

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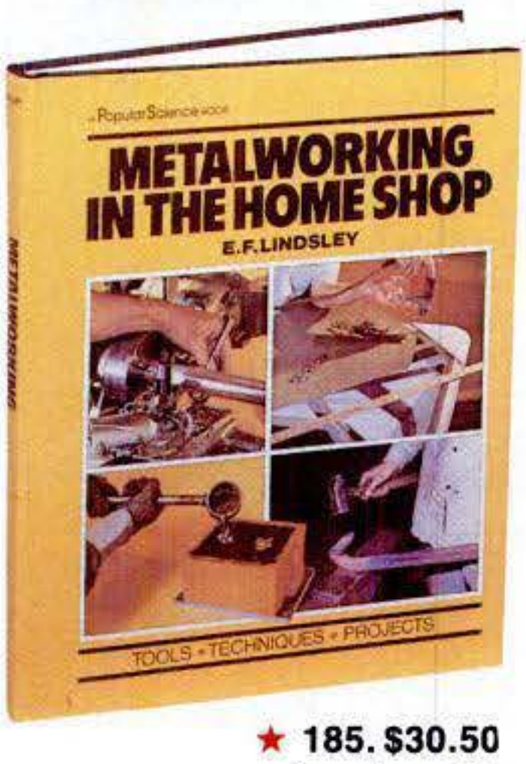

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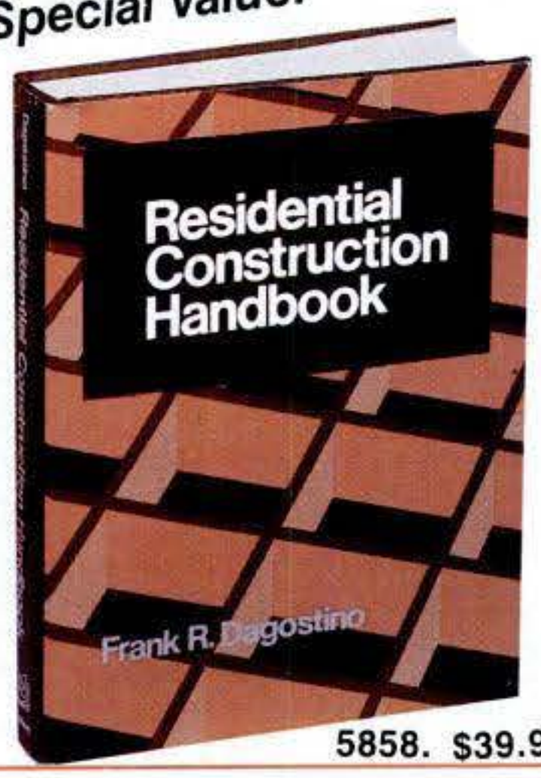

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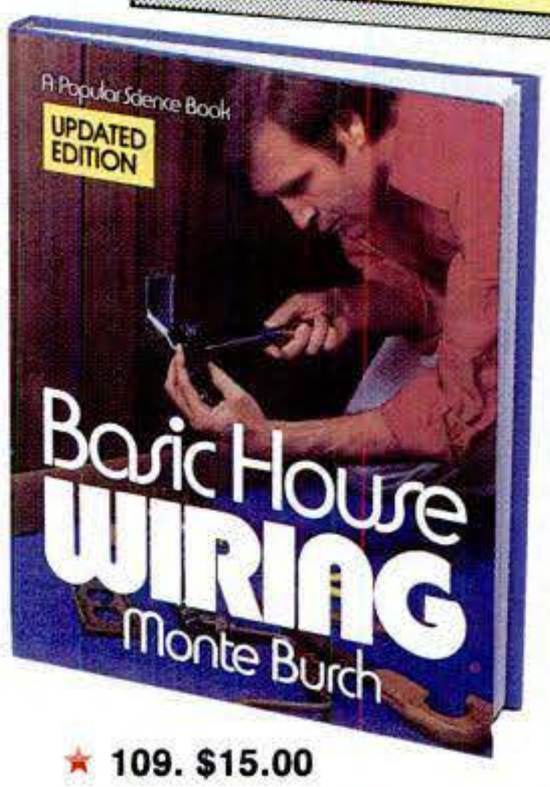

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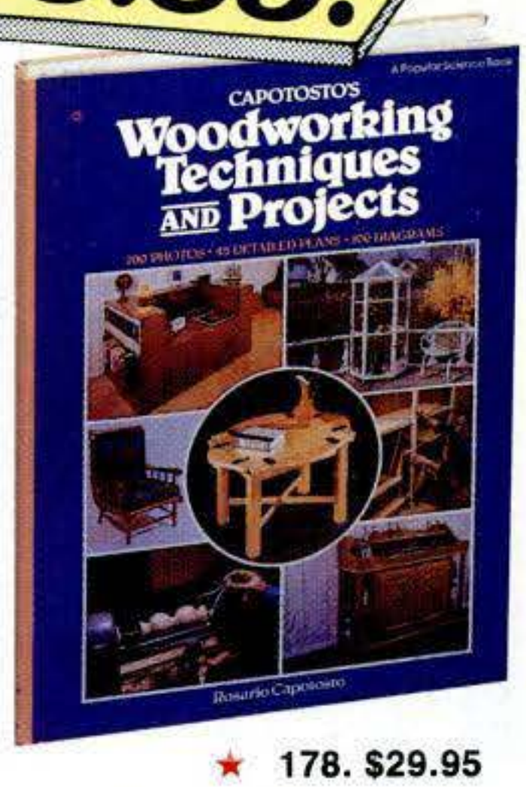

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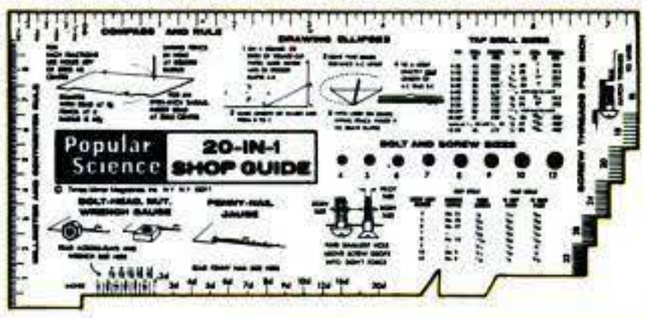

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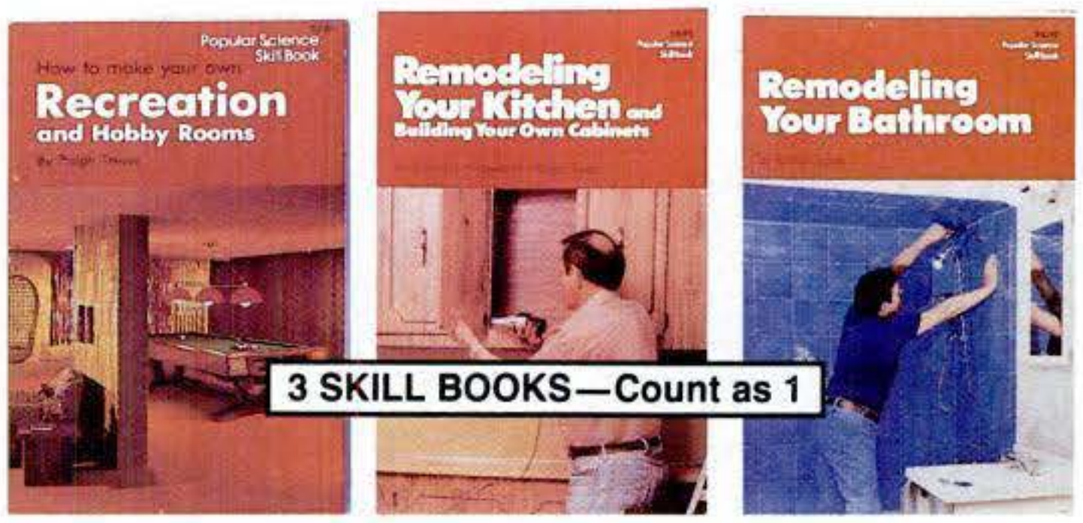

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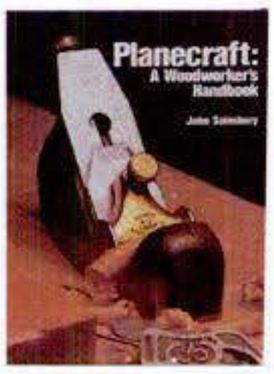

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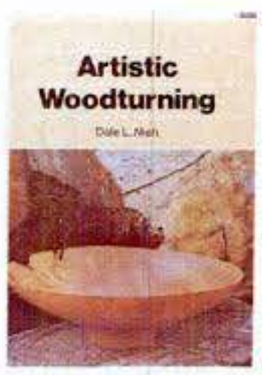

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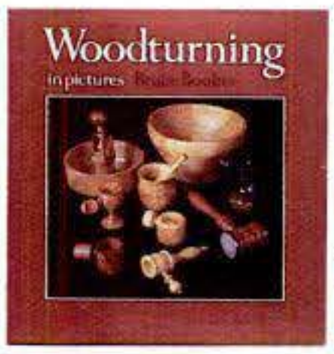

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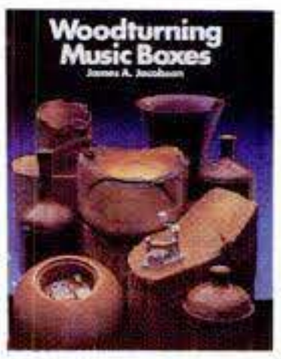

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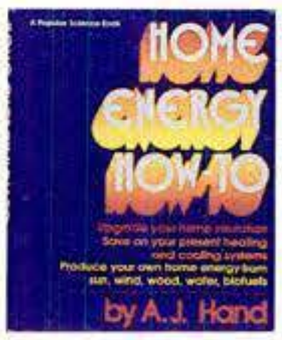

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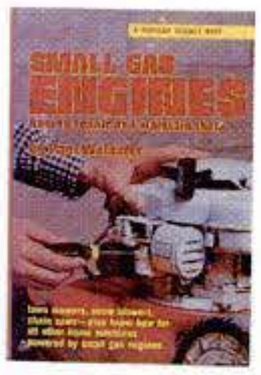

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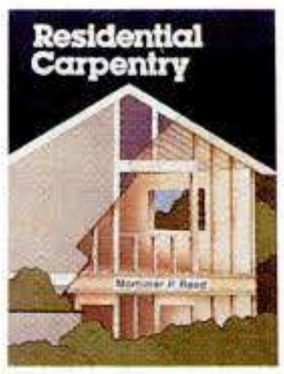

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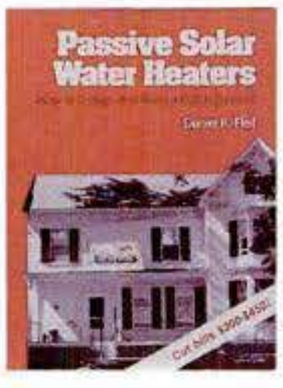

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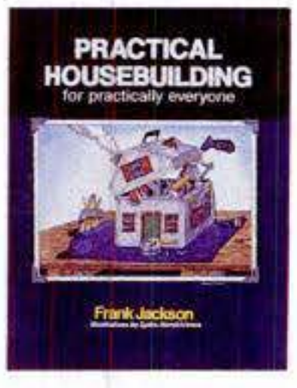

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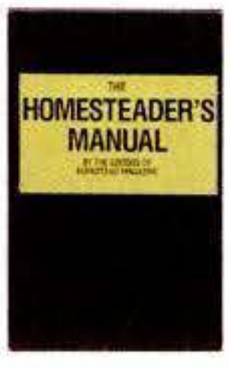

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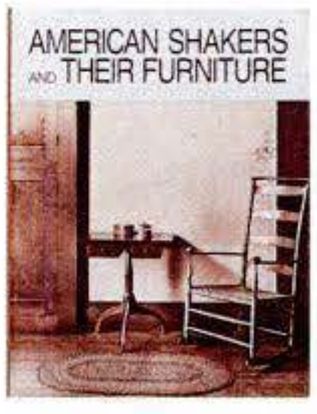

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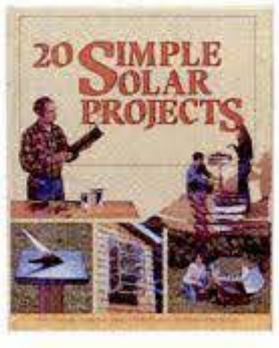

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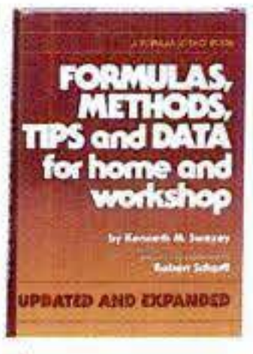

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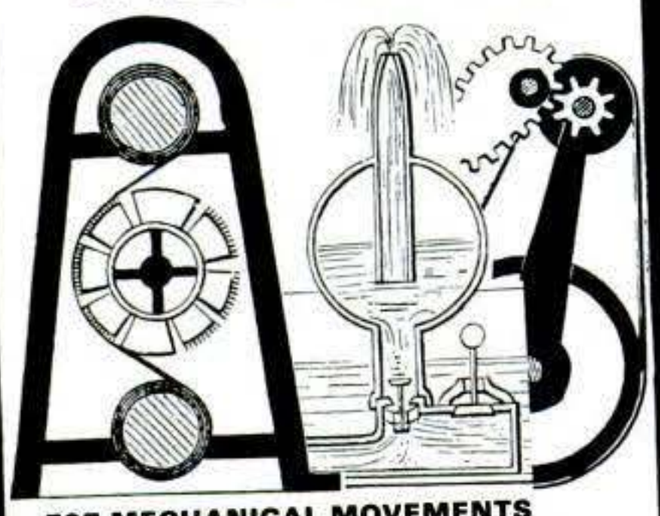

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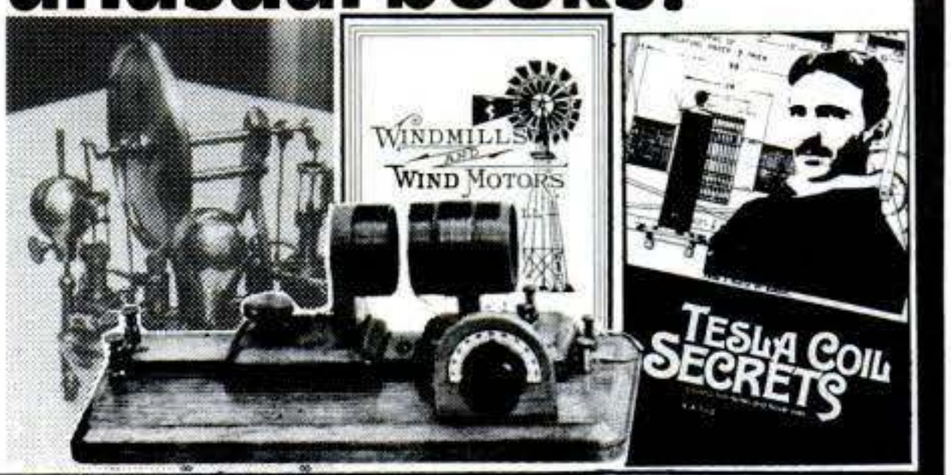

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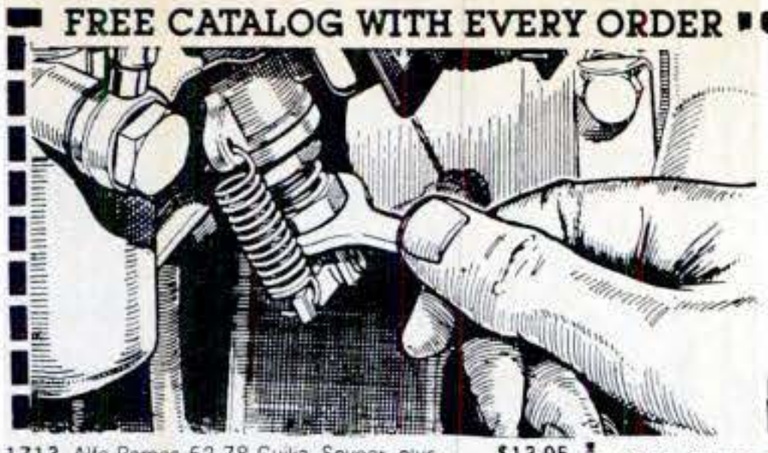

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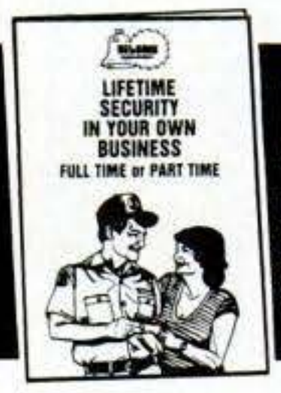

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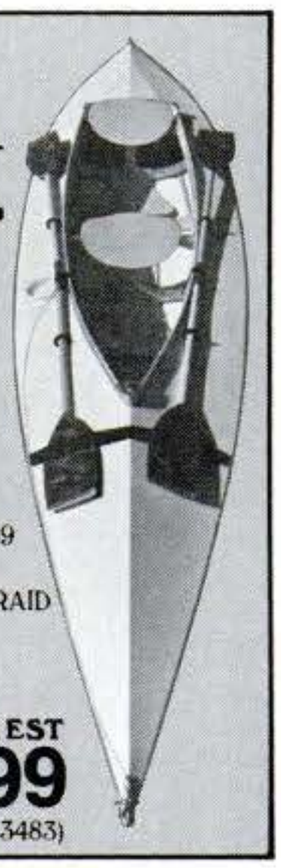

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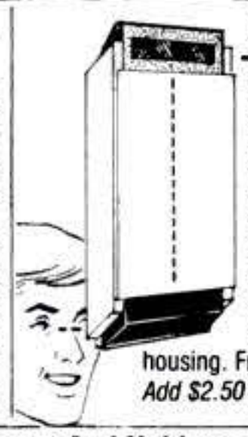

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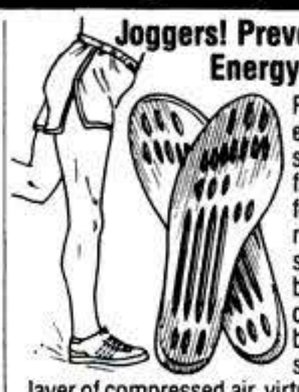

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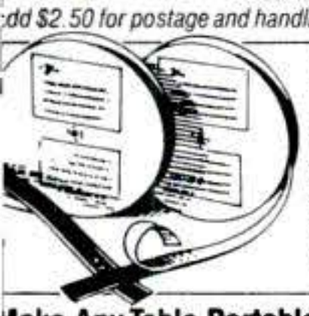

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Add $2.50 for postage and handling. **N71,654 $59.95**
2 tubes of ammo (about 350 shots) N41,005 $6.95

Colorful Nylon Windsock At A Super Low Price Adds Touch Of Color And Pizazz To Your Patio.

We purchased beautiful multi-colored windsocks as close-outs and pass the savings on to you. The streamers with colors of the rainbow will add a touch of color to your patio, porch or boat. Functional, too...cone indicates wind direction. Let us choose for you. We will ship either one 4 ft. sock or two 3 ft. socks...a bargain either way. New condition. Reg. priced at $14.95 each. **N35,544 $7.95**

Add $2.50 for postage and handling.

Radiometer...A Space Age Sphere.

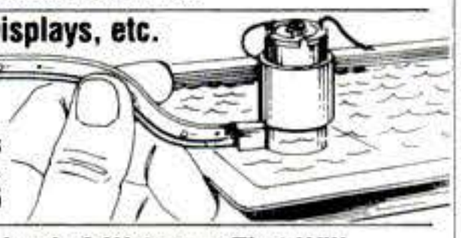
It's fascinating to watch the delicate vanes within this 5" precision-made sphere spin faster and faster illustrating the basic principle of solar heating. When light strikes the vanes it transfers heat, and the vanes begin to move. Works from direct sunlight or artificial light. An attractive "conversation piece" for your home. *Add $2.50 postage and handling* ***Reg. $6.95*** **N60,082 $4.95**

uminous Paint Glows In The Dark.

his amazing phosphorescent paint absorbs nd stores light and glows in the dark with an tra bright, vivid yellow color in minimum light. sed for school posters, window signs and eat for safety applications. Non-toxic and ater soluble. 2 oz. **N31,806 $8.95**

dd $2.50 for postage and handling.

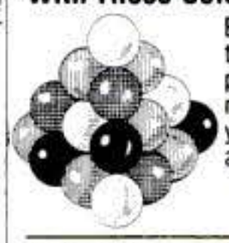
Miniature Water Pump For Photography Darkrooms, Water Displays, etc.



This tiny pump can pump a pint per minute with a 12" high flow. Ideal for temperature control and circulation of darkroom chemicals, table fountains, model waterfalls, water filtration and more. Can be used in either direction and is self priming. Operates on 2 flashlight batteries (not incl.), runs up to 48 hours before battery change is required. 4" tube incl.

Add $2.50 for postage and handling. **N50,345 $6.95**

Fun And Intriguing! You'll Play For Hours With These Colorful Magnetic Magic Marbles.



Build a mountain or odd geometric patterns with these fascinating, high impact plastic marbles. Each marble has both a negative and positive pole. A challenge to your imagination. Fun for youngsters, adults, too! 20 marbles per package.

N35,577 (2 packages) $5.95

Add $2.50 for postage and handling

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N34,553 Star Spangled Banner $29.95
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The modern day version of the famous 1870 Sherlock Holmes reed whistle, made in England. You'll feel more secure in dangerous areas with your personal alarm that produces a piercing sound with a 1 mile range that would detract would be attackers. Brass, nickel plated. **N35,518 $5.95**

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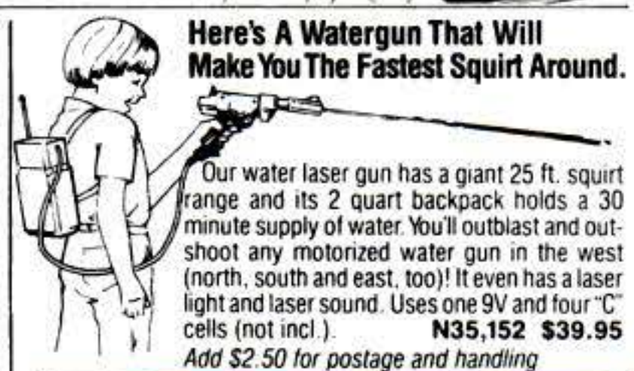
Here's A Watergun That Will Make You The Fastest Squirt Around.



Our water laser gun has a giant 25 ft. squirt range and its 2 quart backpack holds a 30 minute supply of water. You'll outblast and outshoot any motorized water gun in the west (north, south and east, too)! It even has a laser light and laser sound. Uses one 9V and four "C" cells (not incl.). **N35,152 $39.95**

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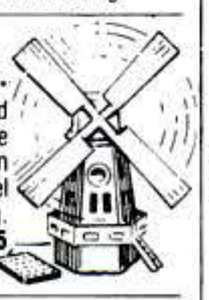
Add $2.50 for postage and handling

uild This Solar Powered Vindmill With Your Own Hands.



erfect for craft enthusiasts, this completed ndmill serves as a demonstrator of the inciples of solar energy. You'll get precision t hardwood parts, a miniature solar panel d complete instructions for assembling. sy to build. 9x4x4" **N35,863 $21.95**

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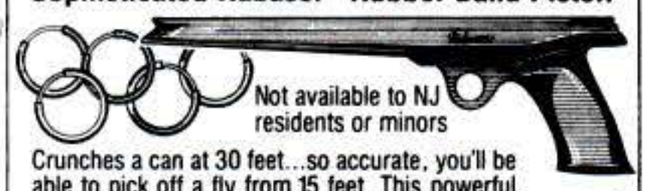

Not available to NJ residents or minors

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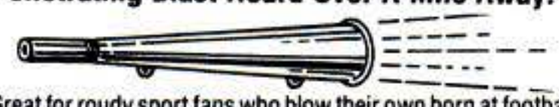

Great for roudy sport fans who blow their own horn at football, hockey, basketball and other sporting events. Originally used by British railway guards to warn work crews of approaching trains. Its 18" long trumpet produces a piercing sound resembling the great foghorns of yesteryear used by ships at sea.

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This new high-tech marvel reads temperature **in your home and outside, too.** Can be wall mounted—just extend the 5 ft. wire sensor out the window and close the window. Operates on one 9V battery (not incl.). Gives readings from −40°F to 199°F, measures 2x3x2¼". ***Reg. $24.95***

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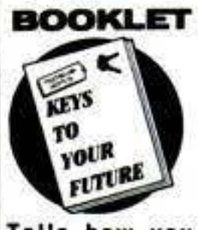

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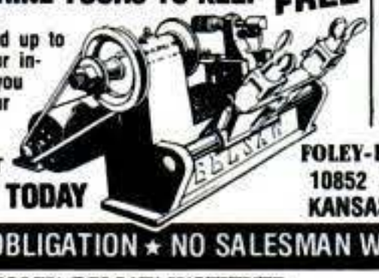

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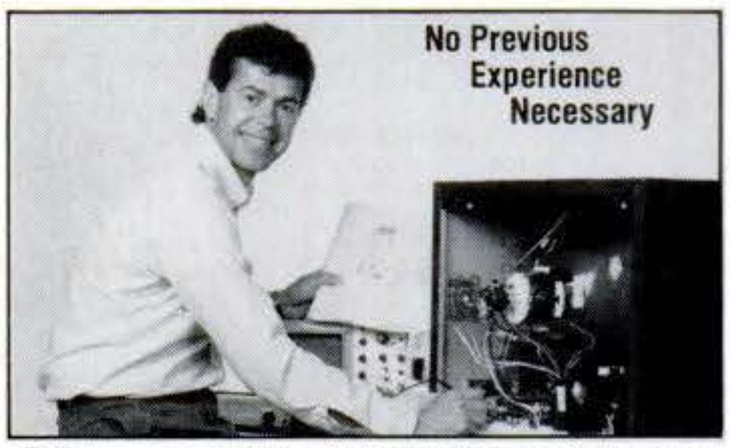

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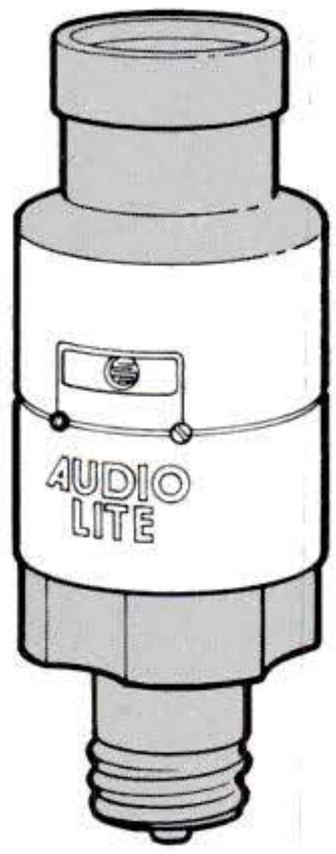
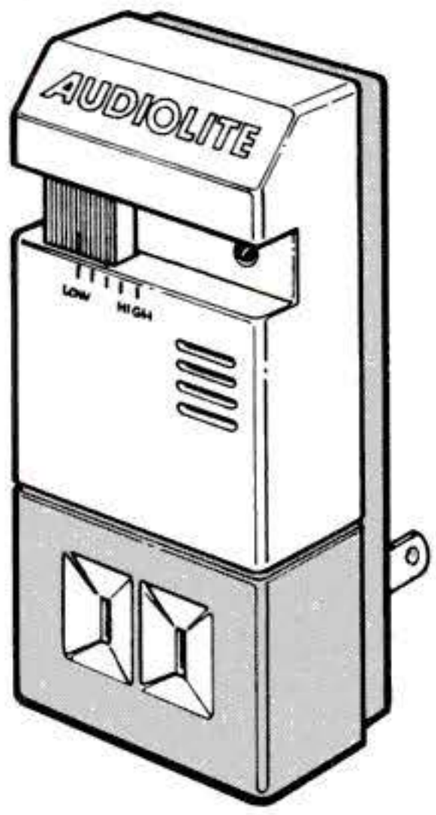
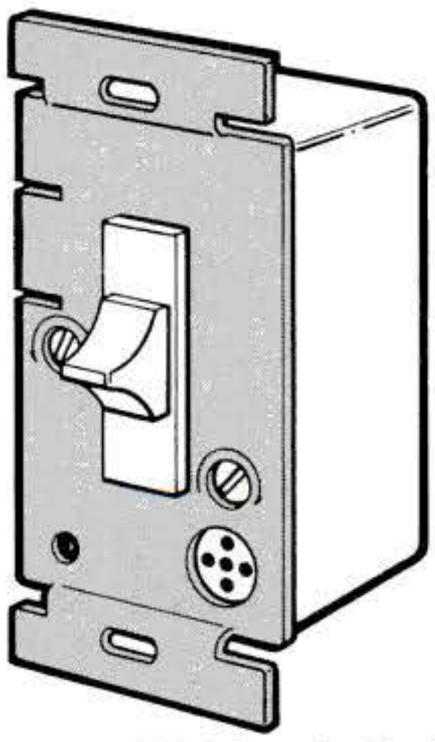


The AudioLite Socket *is as easy to use as screwing in a light bulb. This is the AudioLite created for outside flood lamps, driveways and walkways. Works with up to 150 watts.*



The AudioLite Plug *plugs into any standard outlet and is designed to be used on interior room lamps. Any room with a lamp can be sound activated. The plug is portable and can be used anywhere. Works with up to 300 watts.*



The AudioLite Switch *turns on ceiling lights. It's terrific for dark stairways, hallways, entry ways, basements and garages. It installs quickly and easily in place of your present light switch using just a screwdriver. It takes only a few minutes, even for a novice. Works with up to 200 watts.*

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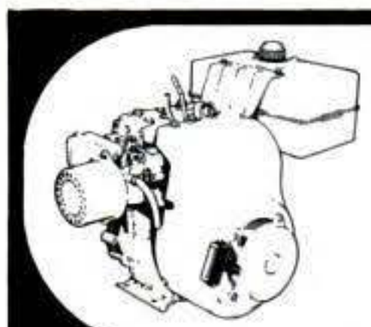

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- *I own two oceanfront condominiums. One is on a sunny beach in Mexico and one is snuggled right on the best beach of the best island in Hawaii.*
- *I have two boats and a Rolls Royce. All paid for.*
- *I have a net worth of well over a Million Dollars. But I still don't have a job...."*

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I remember the day a car dealer got a little nervous because I was a couple of months behind in my payments — and repossessed my car. Now I own a Rolls Royce. I bought it outright — with cash.

I remember the day my wife phoned me, crying, because the landlord had shown up at the house, demanding his rent — and we didn't have the money to pay it.

Now we own five homes. Two are on the oceanfront in California (I use one as my office). One is a lakefront "cabin" in Washington (that's where we spend the whole summer — loafing, fishing, swimming, and sailing). One is a condominium on a sunny beach in Mexico. And one is snuggled right on the best beach of the best island in Hawaii — Maui.

Right now I could sell all this property, pay off the mortgages, and — without touching any of my other investments — walk away with over $750,000 in cash. But I don't want to sell, because I don't think of my homes as "investments." I've got other real estate — and stocks, bonds, and cash in the bank — for that.

When I was 40 I lost my job. Because I was head over heels in debt, my lawyer told me the only thing I could do was declare bankruptcy. He was wrong. I paid off every dime.

Now, I have a million dollar line of credit; but I still don't have a job. Instead, I get up every weekday morning and decide whether I want to go to work or not. Sometimes I do — for 5 or 6 hours. But about half the time, I decide to read, go for a walk, sail my boat, swim, or ride my bike.

I know what it's like to be broke. And I know what it's like to have everything you want. And I know that you — like me — can *decide* which one it's going to be. It's really as easy as that. That's why I call it "The Lazy Man's Way to Riches."

So I'm going to ask you to send me something I don't need: money. Ten dollars to be exact. Why? Because I want you to pay attention. And I figure that if you've got $10 invested, you'll look over what I send you and decide whether to send it back...or keep it. And I don't *want* you to keep it unless you agree that it's worth at least a hundred times what you invested.

Is the material "worth" $10? No — if you think of it as paper and ink. But that's not what I'm selling. What I *am* selling is information. *More* information than I give when I'm paid $1000 as a guest speaker. *More* information than I give in a one-hour consultation for $300.

But you're really not risking anything. Because first, I don't want you to send me any money — at least none that I can use. Instead, as a token of your sincerity, send in your check or money order and *postdate* it for a month from today. You see, it's not really money because it's not negotiable — besides, I won't even touch it for 30 days anyway.

In this way you'll have plenty of time to receive my material, look it over, try it out and *prove* to yourself that everything I am telling you is true.

If you don't agree that it's worth *at least a hundred times* what you invested, send it back. Your *uncashed* check or money order will be put in the return mail.

How do you know I'll do it? Well, if you really want to be on the safe side, postdate your check for a month from today — *plus an additional week*. That way you're sure to have *plenty* of time to receive it, look it over, try it out.

I know what you're thinking: "He got rich telling people how to get rich." The truth is — and this is very important — the year before I shared "The Lazy Man's Way to Riches," my net income was $216,646. And what I'll send you tells just how I made that kind of money...working "part time"...a few hours a day...about 8 months out of the year.

It doesn't require "education." I'm a high school graduate.

It doesn't require "capital." Remember I was up to my neck in debt when I started.

It doesn't require "luck." I've had more than my share. But I'm not promising you that you'll make as much money as I have. And you may do better. I personally know one man who used these principles, worked hard, and made 11 million dollars in 8 years. But money isn't everything.

It doesn't require "talent." Just enough brains to know what to look for. And I'll tell you that.

It doesn't require "youth." One woman I worked with is over 70. She's travelled the world over, making all the money she needs, doing only what I taught her.

It doesn't require "experience." A widow in Chicago has been averaging $25,000 a year for the past 5 years, using my methods.

What does it require? Belief. Enough to take a chance. Enough to absorb what I'll send you. Enough to put the principles into *action*. If you do just that — nothing more, nothing less — the results will be hard to believe. Remember — I guarantee it.

You don't have to give up your job. But you may soon be making so much money that you'll be able to. Once again — I guarantee it.

What I'm saying is probably contrary to what you've heard from your friends, your family, your teachers, and maybe everyone else you know.

I can only ask you one question.

How many of them are millionaires?

So it's up to you.

A month from today, you can be nothing more than a little older — or you can be on your way to getting rich. You decide.

The wisest man I ever knew told me something I never forgot: "Most people are too busy earning a living to make any money."

Don't take as long as I did to find out he was right.

I'll prove it to you, if you'll send in the coupon now. I'm not asking you to "believe" me. Just try it. If I'm wrong, all you've lost is a couple of minutes and a postage stamp. But what if I'm right?

Some have called it a Miracle. Some have called it Magic. You'll call it "The Secret of the Ages."

As for me, I thank God that before he died Millionaire Joe Karbo left, for all to share, the secret of "The Lazy Man's Way to Riches." The above story, which is in his own words, is his gift to you.

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Don't take my word for it. These are excerpts from articles in newspapers and magazines:

Time:
He only works half the year in his stunning office on California's Sunset Beach, and even when he's there he puts in short hours.... In other words, Joe Karbo, 48, is the prototype for..."The Lazy Man's Way To Riches".

Money:
Joe does more than dwell on personal problems; he solves them...
Which is a nice change: Karbo almost went bankrupt back in '62....

Boston Herald-American:
The book has drawn hundreds of letters from persons who have profited by it...

Los Angeles Herald-Examiner:
"Going broke was the best thing that ever happened to me," explains Joe Karbo who went from one business trouble to a million-dollar business fortune...

Forbes:
After bouncing around show biz, advertising, and real estate, he made his fortune....

Money Making Opportunities:
Maybe Joe Karbo has the secret. Don't you think you owe it to yourself to find out what it is all about?...I just finished it — and I'm off on a vacation myself. Get the idea?

Long Beach Independent:
He's programmed the path to riches for the lazy man.

The Kansas City Star:
He prints statements like "Most people are too busy earning a living to make any money." He should have added that too many people these days are too busy earning a living to do any living.

Sworn Statement:
"On the basis of my professional relationship as his accountant, I certify that Mr. Karbo's net worth is more than one million dollars."
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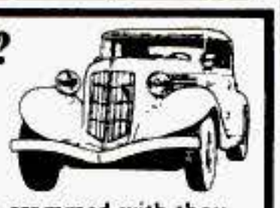

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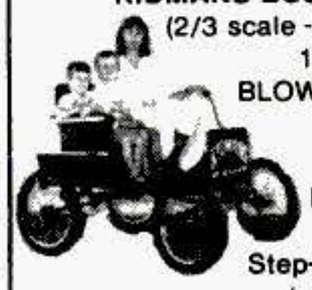

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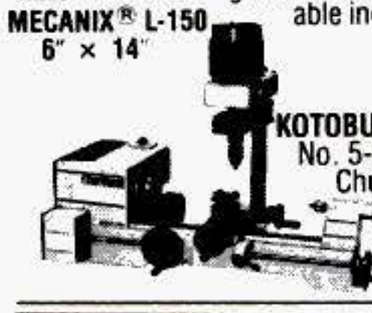

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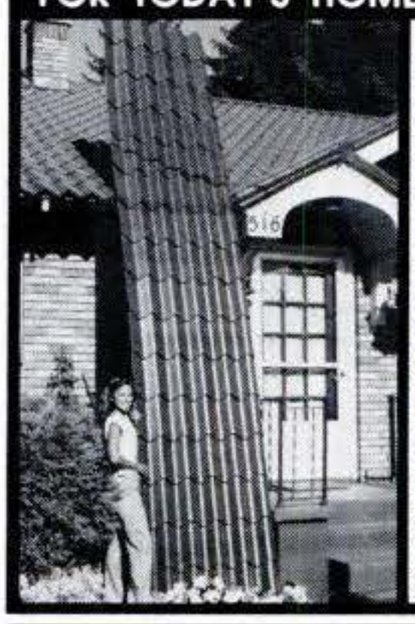

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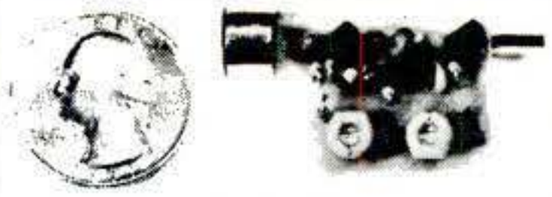

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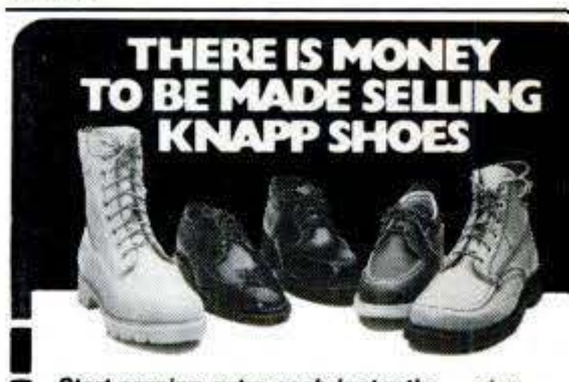

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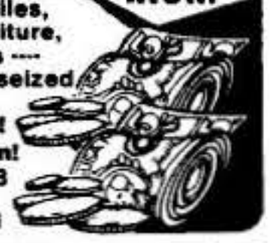

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